PROPOSALS TO BAN NUCLEAR TESTING

HEARINGS AND MARKUP

BEFORE THE

COMMITTEE ON FOREIGN AFFAIRS

AND ITS

SUBCOMMITTEE ON ARMS CONTROL, INTERNATIONAL SECURITY AND SCIENCE

HOUSE OF REPRESENTATIVES

NINETY-NINTH CONGRESS

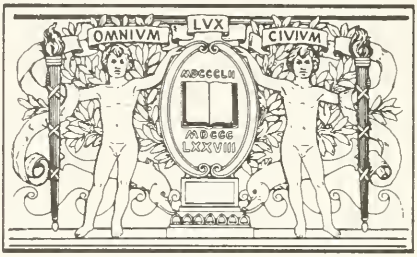
FIRST SESSION

ON

House Joint Resolution 3

FEBRUARY 26; APRIL 30; MAY 8, 14, AND 15, 1985

Printed for the use of the Committee on Foreign Affairs



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PROPOSALS TO BAN NUCLEAR TESTING

TUESDAY, FEBRUARY 26, 1985

House of Representatives,
Committee on Foreign Affairs,
Subcommittee on Arms Control,
International Security and Science,
Washington, DC.

The subcommittee met, at 3:05 p.m., in room 2255, Rayburn House Office Building, Hon. Howard Berman presiding.

Mr. Berman. The subcommittee will come to order.

First, I should express the sincere regrets of Chairman Fascell who had to be in his district today and asked me to chair the meeting in his absence. If there is no objection, I would like to include his opening statement, which I think has been distributed for the record. I would also want to highlight five points that the chairman wanted to make regarding the Comprehensive Test Ban Treaty and his support for it.

[Chairman Fascell's opening statement follows:]

Opening Statement of Hon. Dante B. Fascell

The Subcommittee on Arms Control, International Security and Science begins its first hearing of the 99th Congress by addressing one of the most effective ways to bring an end to the nuclear arms race between the two superpowers—a negotiated ban on nuclear weapons testing.

It is my hope that these hearings and subsequent ones will show that a negotiated ban on nuclear testing: is an effective way to stop both superpowers from adding to their nuclear arsenals; precludes the deployment of costly and destabilizing new nuclear weapons by both superpowers; has wide bipartisan support here in the House and in the Senate and among our allies; complements the administration's arms control objective to reduce the numbers and, more importantly, the quality of nuclear weapons in the arsenals of both superpowers; and builds off nuclear test ban agreements of the Kennedy, Nixon and Ford administrations.

The subcommittee has a number of legislative proposals before it including House Joint Resolution 3 which urges the President to request ratification of the Threshold Test Ban Treaty (Nixon) and the Peaceful Nuclear Explosions Treaty (Ford) and to resume negotiations on a Comprehensive Ban Treaty.

We are honored to have Rep. Berkley Bedell (D-IA) testify before us today on his legislative proposal, H.J. Res. 3. I understand that our colleague on the subcommittee, Rep. Jim Leach is also a sponsor of this resolution and will have a brief statement to make on the resolution.

Rep. Barbara Boxer (D-CA) is also before us today to testify on behalf of her resolution, H.J. Res. 119, the nuclear test ban challenge.

The subcommittee is honored to hear today from Senator Mathias (R-MD) and Senator Edward Kennedy (D-MA). Both Senators spearheaded the debate in the Senate last year on an amendment to the FY85 DOD bill which overwhelmingly passed the Senate. The amendment, I understand, and H.J. Res. 3 contain the exact same language urging ratification of the two testing treaties and resumption of negotiations on a Comprehensive Test Ban Treaty.

And finally, it is a pleasure to have before the subcommittee today the Honorable Walter Stoessel, Jr., the U.S Chief Negotiator to the Threshold Test Ban Treaty and the Peaceful Nuclear Explosions Treaty talks under the Nixon and Ford administrations as well as former Ambassador to Poland, West Germany and the Soviet Union.

We look forward to hearing from our distinguished witnesses today on the merits of past testing agreements and the merits of a comprehensive ban on nuclear weapons testing.

Mr. BERMAN. Chairman Fascell feels, first of all, that a negotiated nuclear test ban would inhibit both superpowers from adding new generations of weapons to their nuclear arsenals.

Second, a nuclear test ban would impede the deployment of costly and destabilizing new nuclear weapons by both superpowers.

Third, a nuclear test ban has wide support. It has been demonstrated in both parties, in both Houses of Congress, and among our allies. A nuclear test ban complements the administration's arms control objective to reduce both numbers and quality of nuclear weapons.

Finally, a nuclear test ban builds on nuclear test ban agreements of the Kennedy, Nixon, and Ford administrations.

The hearing today will examine two policy questions: Should the United States ratify two nuclear test ban treaties it has negotiated with the Soviet Union? That is the Threshold Test Ban Treaty and the Peaceful Nuclear Explosions Treaty. Second, should the United States resume negotiations on a Comprehensive Test Ban Treaty? We will examine the risks and benefits of negotiated restraint on nuclear testing as well as risks and benefits of continuing nuclear tests without new restraints.

In addition to the members of the subcommittee, we are very pleased and honored to have with us an individual Member from New York who has distinguished himself with his knowledge and leadership in this area, Congressman Downey from New York, and of course, some excellent witnesses. I take it the decision is to start with two Senators as a panel, and we welcome both Senator Mathias and Senator Kennedy, who have done so much in the Senate in this area. Whichever of you gentlemen wishes to go first may.

STATEMENT OF HON. EDWARD M. KENNEDY, A U.S. SENATOR FROM THE STATE OF MASSACHUSETTS

Senator KENNEDY. Thank you, Mr. Chairman.

I first of all want to express our appreciation to you, the members of the committee, for holding these hearings, and we also want to thank our colleagues in the House for permitting us to testify at this time.

As the Chair probably knows, we are about to consider, almost momentarily, some important legislation dealing with the farm issue in the Senate of the United States, so we very much appreciate the chance to start the hearings off. We are grateful to our colleagues here who are fully committed on this issue and who wish to testify.

If I could, Mr. Chairman, I have a brief statement. I do think if I go through it, it is the most complete comment on this case. It will take maybe 4 or 5 minutes. As I indicated, I want to thank Chairman Fascell for having these hearings. I want to thank our colleagues, Berkley Bedell, Jim Leach, and Ed Markey for their leadership on House Joint Resolution 3,[1] and to thank Chairman Fascell for his strong support and commitment.

As the committee knows, the resolution contains two provisions. It calls upon the President, at the earliest possible date, to first, request the Senate ratification of the Threshold Test Ban Treaty and the Peaceful Nuclear Explosions Treaty with any plans the President may have to negotiate supplemental verification or any reservations or understandings he feels necessary. That is somewhat different from the resolutions which we have introduced in previous years, but I think it will address some of the concerns that Members have expressed on the issues of verification.

Second, to propose to the Soviet Union immediate resumption of the Comprehensive Test Ban Treaty negotiations. This resolution is identical to the one offered by Senator Mathias and myself which passed the Senate in 1984 by a 77 to 22 vote on the DOD authorization bill. It is particularly appropriate, Mr. Chairman, to have these hearings, because as a member of the conference committee on that legislation, a number of the Members of the House had indicated that they had not had an opportunity to examine, in the kind of detail that they would like on that particular measure.

The TTBT signed by President Nixon in 1974 and the PNET signed by President Ford in 1976, limit underground nuclear explosions to devices with a force of 150 kilotons of TNT or less. The treaties have never been ratified by the Senate. Both sides are agreed to abide by their terms. Ratification now would serve several important purposes. First, after the unsatisfactory experience with SALT II, it would send a signal that the U.S. Senate is serious about arms control. Currently, we exist in an arms control twilight zone of signed, but unratified arms control agreements.

Second, ratification will bring into being several verification and compliance provisions which have not been implemented due to our failure to ratify the treaties, including the exchanges of geological data under the TTBT that will clarify the ambiguities about the size and locations of tests and onsite inspection under the PNET.

Finally, the ratification of these treaties will help set the stage for the achievement of a comprehensive test ban treaty. The arguments against ratification of these two treaties are unsupportable. Some have argued that we should not ratify the treaties because the Soviets are already violating them, or that they cannot be verified. Most experts believe that the data on Soviet testing are entirely consistent with compliance.

I mention at this time, Mr. Chairman, that there is a division even within the Government laboratories. Scientists at Los Alamos indicate that they believe that tests have been conducted by the Soviet Union that could be interpreted as violating the 150 kiloton provision. Other scientists at Livermore Laboratories do not draw that conclusion. DARPA, the responsible agency within the Defense Department, in its working document, in its first draft, agrees with the Scientists of Livermore Laboratories at this time.

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[1] See text in appendix 1.

Moreover, the advanced verification techniques in the treaties which will go into effect upon ratification will enhance our confidence in Soviet compliance. It is ironic that those who refuse to accept the arms control without progress on verification are refusing to implement agreements that would accomplish the very progress on verification that they profess to seek.

Ratification of the two treaties is the first step toward the goal of a comprehensive test ban treaty. CTB by itself will not end the arms race, but it does play an important role in putting a brake on the unending proliferation of weapons systems. The CTB will also strenghten our hand in dealing with another of the most serious threats facing the Earth for the remainder of the century and beyond; the spreading of nuclear weapons to the other nations.

Under the NPT, the nonnuclear weapon states agree not to develop nuclear in return for a pledge by the weapons states to pursue arms control, especially a CTB. Turning away from the CTB would undermine that agreement so critical to our long run security. With the approach of the third NPT review this summer, it is vital that the United States and the Soviets move forward again on our pledge to work toward a CTB.

Verification is a critical issue. We do not enter into nuclear arms control agreements because we trust the Soviets, but because it is in the mutual interest of both our nations to avoid mutual destruction. The value of a treaty is not necessarily nullified because one side or the other might be able to violate the agreement without detection. The essential questions are whether any such violation would harm our national security, and whether we are better off with or without the treaty.

As new verification techniques expand our ability to monitor Soviet compliance, the possibility of militarily significant violation grows more and more remote. With in-country monitoring and onsite inspection, both of which the Soviets have agreed to, an effective CTB is within our grasp. We also talk a great deal about the need to assure the reliability of a nuclear stockpile; many of these issues can be resolved without nuclear testing. Reliability testing on proven systems is rare.

Some testing may be needed in the long run to assure the credibility of our existing deterrent. Provisions can be negotiated in a CTBT that address this problem without permitting the development of a new generation of weapons. This resolution does not specify the terms of a CTB, it simply calls on the President to return to the bargaining table.

Every administration since President Eisenhower's, Democrat and Republican, has supported and worked for a CTB. President Reagan's decision to abandon the CTB negotiations in 1982 and not to seek ratification of the two pending treaties was a departure from this long-held consensus. I am hopeful that when the House of Representatives adds its voice to the overwhelming vote in the Senate of last year, we can at last resume our progress on this important aspect of nuclear arms control.

Finally, Mr. Chairman, I want to say we offer this in the spirit of recognition of the signal achievements of the Secretary of State in working toward the opening of these arms control talks in Geneva in the next 2 weeks. We are very hopeful that this will be considered as a complementary action to the administration's effort. In the Armed Services Committee, I inquired of Secretary of Defense Weinberger, who had indicated that these issues are on a different track from the three items which have been outlined for negotiation at Geneva, and we are very hopeful that there can be a clear expression of Congress, in a bipartisan way, that would be considered by the administration as to be a constructive, positive, and complementary expression by the Congress of the United States on this issue.

[Senator Kennedy's prepared statement follows:]

Prepared Statement of Senator Edward M. Kennedy

Mr. Chairman, and members of the Committee. Thank you for the opportunity to testify on this important legislation. I want to commend Berkley Bedell, Jim Leach and Ed Markey for their leadership on H.J. Res. 3. And I also commend Chairman Fascell for calling these timely hearings on this essential aspect of nuclear arms control.

The world is waiting with anticipation and hope for the arms talks next month between the U.S. and the Soviet Union. All of us in Congress are united in our desire for successful negotiations that will end, once and for all time, the spectre of nuclear annihilation that shadows all the earth.

It is especially appropriate, therefore, that we meet to consider this long-pending bipartisan legislation, which requests the President, as part of the overall arms control process, to submit the Threshold Test Ban Treaty and the Peaceful Nuclear Explosions Treaty to the Senate for ratification, and to resume negotiations for a comprehensive test ban treaty.

For over twenty years, ever since the ratification of the Partial Test Treaty negotiated by President Kennedy in 1963, one of the most important and most widely shared goals of arms control has been to halt all nuclear testing on both sides and thereby to prevent the development of even more dangerous generations of these weapons.

Over the past decade, I have sponsored a number of resolutions urging a comprehensive test ban, and we have achieved significant progress toward achieving this goal. Last year, the Senate adopted our resolution urging this action by a strong bipartisan vote of 77-22. I am hopeful that with the support of this Committee, the House of Representatives will now join the Senate in requesting the Administration to resume CTB negotiations, and that the President will hear and heed our message.

The Threshold Test Ban Treaty was signed by President Nixon in 1974, and the Peaceful Nuclear Explosions Treaty was signed by President Ford in 1976. Together, the two treaties limit underground explosions to devices with a force of 150 kilotons of TNT or less. The treaties have never been ratified by the Senate, but both sides have agreed to abide by their terms.

In spite of a decade of delay, the two treaties are as current as the day they were signed. And ratification now would serve several important purposes.

First, after the unsatisfactory experience with SALT II, it would send a signal that the United States Senate is serious about arms control—that we are prepared to place the full weight of the Legislative Branch as well as the Executive Branch behind these agreements. Currently, we exist in an arms control twilight zone—in fact, the last three major arms control treaties have been signed, yet not ratified; two by Republican Presidents, one by a Democrat. We continue to abide by the treaties, yet we are unwilling to act to make them binding.

Second, ratification will bring into being several verification and compliance provisions which have not been implemented due to our failure to ratify the treaties. In particular, the Threshold Test Ban Treaty provides for exchanges of geological data that will clarify ambiguities about the size and location of tests. And the Peaceful Nuclear Explosions Treaty sets an important precedent on verification, by providing for on-site inspection whenever it is unclear whether a test is peaceful. The Soviet's willingness to accept some form of on-site inspection was reiterated in the CTB negotiations.

Finally, ratification of these treaties will help set the stage for the achievement of a comprehensive test ban treaty.

Some have argued that we should ratify the treaties because the Soviets are already violating them. But the vast weight of expert opinion has concluded that the data on Soviet testing are entirely consistent with compliance. Moreover, the advanced verification techniques in the treaties, which will go into effect upon ratification, will enhance our confidence in Soviet compliance.

For the same reason, it is difficult to accept the contention that the treaties as written are unverifiable. On the merits, this argument is rejected by the overwhelming weight of scientific opinion. It is ironic that those who make this argument refuse to accept arms control without progress on verification—and then refuse to implement agreements, achieved through negotiation, that would accomplish the very progress on verification they profess to seek.

Ratification of these two treaties is the first step toward the goal of a comprehensive test ban treaty. We should neither over-estimate, nor under-estimate, the value of such an agreement. A CTB will not end the arms race—it will not by itself lead to the dismantling of dangerous and destabilizing weapons systems. But it does play an important role in putting a brake on the unending proliferation of weapons systems; and it can lead to sharp reductions in nuclear weapons that will lessen the risk of nuclear war. A CTB would limit the development of dangerous new—so called third generation—nuclear weapons, while preserving U.S. superiority in critical areas such as micro-circuitry, safety and security, and command and control.

A CTB will also strengthen our hand in dealing with another of the most serious threats facing the earth—the spread of nuclear weapons to other nations.

Under the Non-Proliferation Treaty, non-nuclear weapon states agree not to develop nuclear weapons in return for a pledge by the weapon states to pursue arms control—especially a CTB. This solemn pledge, in Article VI of the Treaty, is a vital linchpin of the NPT regime. Turning away from the CTB could undermine that agreement, so critical to our long-run security.

With the approach of the Third NPT Review Conference this summer, it is vital that the U.S. and the Soviets move forward again on our pledge to work toward a CTB, to prevent further erosion of support for the NPT, and to advance our credibility with nations who have not yet agreed to abide by its terms.

Much of the heat and light in discussions of CTB is generated by questions of verfiability. Verification is critical—we do not enter into nuclear arms control agreements because we trust the Soviets, but because it is in the mutual interest of both our nations to avoid mutual destruction.

At the same time, the value of a treaty is not necessarily nullified because one side or the other might—with imagination and adequate resources—be able to violate the agreement without detection. The essential questions are whether any such violation would harm our national security—and whether we are better off with or without the treaty. As new verification techniques expand our ability to monitor Soviet compliance, the possibility of military significant violations grows more and more remote. With in-country monitoring and on-site inspection—both of which the Soviets have agreed to—and effective CTB is within our grasp.

We also hear a great deal about the need to assure the reliability of our nuclear stockpile. Many of these issues can be resolved without nuclear testing, and reliability testing of proven systems is rare. If some testing is needed in the long run to assure the credibility of our existing deterrent, provisions can be negotiated in a CTBT that address this problem, without permitting the development of a new generation of weapons. The resolution I support, like the one passed by the Senate last year, does not specify the terms of a CTB—it simply calls on the President to return to the bargaining table.

Every Administration since President Eisenhower's, Democratic and Republican, has supported and worked for a CTB. President Reagan's decision to abandon CTB negotiations in 1982 and not to seek ratification of the two pending treaties, while still observing them was a departure from this long-held consensus. I am hopeful that, when the House of Representatives adds its voice to the vote of the Senate last year, we can at last resume our progress on this important aspect of nuclear arms control.

Mr. Berman. Thank you very much, Senator Kennedy.

Senator Mathias.

STATEMENT OF HON. CHARLES McC. MATHIAS, JR., A U.S. SENATOR FROM THE STATE OF MARYLAND

Senator Mathias. Thank you, Mr. Chairman. I join with Senator Kennedy in thanking you and other members of the committee for affording us this opportunity to discuss House Joint Resolution 3, to prevent nuclear explosive testing.

Senator Kennedy and I have more than a passing interest in the fate of this resolution. Last summer, with the help of many others, but particularly with Senator Sam Nunn's able assistance, we were able to amend the 1985 Department of Defense authorization bill with language very nearly identical to that in House Joint Resolution 3. As Senator Kennedy said, our amendment passed overwhelmingly, by a vote of 77 to 22. This is very convincing, particularly in light of the arithmetic which is current in the Senate: 66 is the magic figure. We demonstrated that there was more than two-thirds of the Senate which would be available for consent to ratification of the treaty, provided the President is then willing to submit the treaty.

I think we both feel that it is important for the House and Senate to be in sync in this matter, and passage of House Joint Resolution 3 seems like a good way to accomplish this. A common position for the House and Senate is more than a mere convenience. With both the Senate and the House of Representatives on record in favor of resumed comprehensive test ban negotiations and of Threshold Test Ban and Peaceful Nuclear Explosions Treaty ratification, then, at the very least, the administration would be under the necessity of justifying its current opposition to these issues.

As Senator Kennedy has just said, an end to nuclear testing has been the clearly stated policy goal of every previous President in the nuclear age. That is something that has to be thought about very seriously. The history of the nuclear test ban is long and I think it is distinguished. It has involved some of our most able and respected diplomats, including Ambassador Stoessel, who will appear before you in a few minutes.

Since 1963, more than 20 years, both the United States and the Soviet Union have been committed by the terms of the Limited Test Ban Treaty to seek to achieve the discontinuance of all test explosions of nuclear weapons for all time. That is the language to which we are committed. Objections have been raised that future options of the United States might be limited by ratification. It seems to me that the business of arms control is to establish limits, and the limits that are established, of course, have to be mutual and they have to be verifiable. But I am afraid that the opportunities to establish such mutual and verifiable limits are not themselves unlimited.

The Threshold Test Ban and the Peaceful Nuclear Explosions Treaties both establish mutual and verifiable limits, and the conclusion of a verifiable test ban treaty would be, I think, the sanest milestone in this brief history of the nuclear age. Now, there are, of course, serious objections that are raised. One of them is that the Russians are so intransigent at the moment that we ought not reward them by any kind of gesture. Well, it doesn't seem to me that House Joint Resolution 3 in any sense rewards intransigence. I think it is more a case of recognizing that we want to avoid self-inflicted wounds, and that by not acting when action is clearly indicated, we would be in danger of committing such to self-inflicted injuries.

I don't think that we are talking here about any new proposal which could be interpreted as appeasement. To complete work that was begun by President Nixon in the one case, and President Ford in the other, is simply winding up some sound concepts that have been pending on our agenda for a long time.

I had the opportunity recently to visit the Soviet Union, and I regret to say that I was not very much encouraged by what I saw and heard to think that the road ahead is going to be easy, particularly in reference to the umbrella negotiations that will open in Geneva. It really requires some pondering to consider why the Russians with whom I met felt that it was important to create such a pessimistic attitude, such a pessimistic climate.

Now, I am not without all hope for some progress in Geneva, but having had this recent experience, I believe more than ever that the United States should keep alive all of the realistic arms control options, and that includes in particular the test ban issue. During the debate on the Senate amendment last summer, some of its opponents referred to the enormous risks presented by the amendment and therefore, I assume they would raise the same kind of alarms with respect to House Joint Resolution 3.

Now there is a risk involved, but I would submit to the committee that the risk is in failing to adopt the resolution, because the cycle of escalation and proliferation is really the greatest danger. This resolution offers a prudent course to a safer world by restoring the United States to its proper place in the search for stability and for peace.

Mr. Chairman, if I can rest at this point, we will be happy to entertain your questions.

[Senator Mathias' prepared statement follows:]

Prepared Statement of Senator Charles McC. Mathias, Jr.

Thank you, Chairman Fascell, and members of the Committee, for inviting Senator Kennedy and me here today to offer testimony in support of House Joint Resolution 3, to prevent nuclear testing. The resolution specifically seeks Presidential consent to ratification of the 1974 Threshold Test Ban (TTB) and 1976 Peaceful Nuclear Explosions (PNE) Treaties, and to immediately resume Comprehensive Test ban Treaty (CTBT) negotiations.

I must confess that Senator Kennedy and I have more than a passing interest in the fate of this resolution. Last summer, with the help of Senator Sam Nunn, we successfully amended the FY 1985 DoD Authorization Bill with language identical to that contained in H.J. Res. 3. Our amendment passed overwhelmingly, 77–22, and is clear evidence that we can muster the two-thirds of the Senate necessary for consent to ratification—provided the President is then willing to submit the treaties in question to Senate action. We both further feel that it is important for the House and Senate to be in legislative "synch" on the test ban issue, and passage of H.J. Res. 3 seems like the best way to accomplish this.

A common House and Senate position is more than merely convenient. With both the Senate and the House of Representatives on record in favor of resumed CTBT negotiations and TTB and PNE Treaty ratification, the Administration would be under the necessity to justify its current position of opposition. After all, an end to nuclear testing has been a clearly stated policy goal of every President in the nuclear age—with the exception of Ronald Reagan.

The history of the nuclear test ban issue is a long and distinguished one. It has concerned and involved some of America's ablest and most respected diplomats, including Ambassador Stoessel. Since 1963, both the United States and the Soviet Union have been committed, by the terms of the Limited Test Ban Treaty (LTBT), to seek "to achieve the discontinuance of all test explosions of nuclear weapons for all time."

Objections have been raised in some quarters that future options of the United States might be limited by ratification of the Threshold Test Ban and Peaceful Nuclear Explosions Treaties and by conclusion of a Comprehensive Test Ban Treaty. It seems to me that the business of arms control is to establish limits, and the limits that are established have to be mutual and verifiable. However, the opportunities to establish mutual and verifiable limits are not unlimited.

The TTB and PNE Treaties both establish mutual and verifiable limits, and the conclusion of a verifiable CTB Treaty, which Senator Kennedy and I both urge, would be the sanest milestone in the brief history of the nuclear age.

It has been said by some thoughtful observers that Russian behavior at the moment is so intransigent that the United States should not reward it by even a gesture. H.J. Res. 3 does not in any way reward intransigence. I think this is more a case of avoiding self-inflicted wounds, self-inflicted injuries, by not acting when action is clearly demanded by circumstance. The United States is deeply committed to the TTB and PNE Treaties. They involve no new proposal that has not been thoroughly digested on all sides. It surely could not be called appeasement to complete the work begun by Presidents Nixon and Ford. And, as I mentioned before, A CTB Treaty has heretofore enjoyed bipartisan Presidential support.

I had the opportunity to visit the Soviet Union recently, and I must say that I was not encouraged by what I saw and heard to think that the road ahead would be easy, particularly in reference to the upcoming umbrella negotiations in Geneva. One must wonder why the Soviets with whom I met felt it important to create such a pessimistic climate—I do not believe it was all done for propaganda purposes. While I continue to harbor some hope for modest progress at the Geneva sessions, my contact with Soviet officials convinced me that the United States should keep alive all realistic arms control options, the test ban issue in particular.

The upcoming Geneva talks will be very much like starting from scratch; I would concede that that's better than not starting at all. But the test ban issue, with all its extensive legislative and diplomatic history, should be further cultivated instead of abandoned. We need to make what progress we can, where we can. Arms control must not be a place where the best becomes the enemy of the good.

During this summer's consideration of the Senate test ban amendment, opponents referred to the "enormous risks" presented by our amendment and, by extrapolation, H.J. Res. 3. I agree that enormous risk is present, but in my judgment the risk lies in failing to adopt the resolution. To stand silent while we are locked in a fatal cycle of escalation and proliferation is the greatest danger. This resolution offers a prudent course to a safer world. It restores the United States to its proper place in the search for stability and peace.

Opponents of our amendment also referred to it as "unilateral," but in doing so ignored the fact that it asked no more or no less of the United States than it did of the Soviet Union. The same is true of H.J. Res. 3.

It was also said in opposition to the amendment that it flew in the face of experience with Russian treaty compliance. The record on that subject is too well known to repeat here. Let me only say that with reference to the Threshold Test Ban Treaty there are seismic anomalies that are known to exist. The Joint Chiefs of Staff knew about this factor when they endorsed the TTB Treaty. It is commonly called the "factor of two" and means that a 150 kiloton nuclear test (the maximum yield permitted by the accord) could be recorded as anywhere between 75 and 300 kilotons. This was fully considered at the time the treaty was negotiated. It was not judged to be an insurmountable problem.

With reference to resumed Comprehensive Test Ban Treaty negotiations, amendment opponents again referred to risks. Possible benefits were not mentioned. In all the serious decisions of life the pros and cons must be weighed and evaluated. In my opinion there are some risks in making any kind of agreement, but that in this case the benefits are more important. The arms control benefits would be significant, but there would be other advantages as well. It would have a political impact that would surely be positive. Even more important, it would respond to the need of humanity for some hope that the scourge of nuclear weapons may be banished from the Earth.

The Congress is in a unique position to bring efforts for a Comprehensive Test Ban Treaty into sharp focus. We must constantly remind ourselves of Congress' pivotal role in this endeavor. For despite our best efforts, the Administration has not responded in even a small way to the overwhelming signal from the Senate. It is essential that the House of Representatives join this rising chorus of legislators favoring a CTB Treaty. Let's face it, in the current climate, it is up to Congress to define the parameters and potential of the test ban issue; whatever action we take determines progress on the test ban issue for the year. Simply wishing for increased Executive Branch interest in TTBT and PNET ratification and resumed CTBT talks will not make it so. The Administration must be persuaded of the positive contribution that such steps make to the security of the United States. The seriousness of the Congressional commitment to the cessation of all nuclear tests for all time is an important element in the process because of the constitutional responsibility of Congress to provide for the common defense.

I applaud the Foreign Affairs Committee for leading the Congress in an effort that will educate the public as well as ourselves. It is high time for the United States to get serious about this goal, and I hope for prompt, favorable House action on H.J. Res. 3.

Mr. BERMAN. Thank you very much, Senator Mathias.

Mr. Barnes.

Mr. BARNES. Mr. Chairman, I do not have any questions, I just want to commend the two distinguished Senators for their leadership on what is an enormously important issue; arguably the most important issue that any of us will ever have to deal with. I hope that our colleagues on the committee and in the House will heed your strong bipartisan message this afternoon. I think it is an extremely important one. I am just very pleased that you took the time and trouble. I know the Senate has been pretty busy the last few days on other very important issues. I think it is another indication of your leadership that you take the time and trouble to come over here and testify this afternoon and I for one am very grateful to you.

Senator MATHIAS. Thank you very much.

Mr. BERMAN. I just might add, I assume whatever secret method you have of finding out whether there is a vote over there, you will let us know it at that time?

Senator KENNEDY. I am relying on Senator Mathias for that.

Mr. BERMAN. Congressman Leach.

Mr. LEACH. Thank you, Mr. Chairman. I have a lengthy statement I would like to add after Mr. Bedell speaks.

I would like to ask our two distinguished crosstown representatives about a subtlety that has eluded me in terms of senatorial prerogative. The resolution that you have passed called on the President to resubmit the Threshold Test Ban and the Peaceful Nuclear Explosions Treaty to the Senate for ratification. Does he need to, for you to ratify, or can the Senate on its own prerogative ratify without action by the President himself?

Senator KENNEDY. Clearly we have the power to do that, Congressman, but I think as a practical matter, it is quite unrealistic to expect that we would ratify the treaties if they did not have the support of the President of the United States; were he not to express a position favorable to that particular undertaking. But as a technical matter, we do have the authority and the power. I think what we are looking for here is recognition for the American people that these are treaties that are being observed at the present time certainly by the United States, and this committee can make the judgment and determination given the cross evidence as to the Soviet Union's response.

We do believe that it is of sufficient importance that we have the President speak to this issue and to provide the guidance for the American people that it is important for the reasons that we have outlined.

Senator MATHIAS. Yes, Mr. Leach, as your question correctly implies, the treaties have been before the Senate Foreign Relations Committee since 1978, and therefore, have been submitted to the Senate. As Senator Kennedy said, in theory, we could act on them at any time. There is both, however, a practical and a philosophical reason that we cannot. The practical reason is that that magic figure of 60 or 66 can work against you as well as for you. It would be impossible to bring it to a vote in the Senate, as a practical matter, if any President were opposed to it coming to a vote.

But the philosophical reason for not going forward is, as I understand the spirit of the Constitution, is that foreign policy will be a matter of the coordinated action of the President and the Congress. If the President is unwilling to coordinate in this respect, then we really cannot go forward.

Mr. LEACH. Let me just comment in reference to those two treaties, there are three stages in most treaty efforts: One is, obviously, the signature; one is the ratification by the Senate; but the third is the depositive instruments of ratification. The President still has the capacity to hold up, and this would simply be an extra measure of moral suasion on him. I, personally, think that there would be nothing improper about the U.S. Senate taking up a treaty or two treaties, in this instance, that have been signed by the United States of America and presented to the U.S. Senate for ratification. Then, after they have been ratified, if the President, whoever that President might be, refused to deposit the instruments of ratification, he would have that option. I just think it is something that ought to be seriously considered.

Now, having said that, both of those treaties become in one sense not exactly upstaged, but to a degree irrelevant, if we pass a comprehensive test ban treaty, because a comprehensive test ban, in effect, covers peaceful nuclear explosions—or it may not; it could be excluded. It certainly covers threshold test bans, so there is that aspect to it. It makes a CTB even more desirable.

My last question is, Does either of you have any comment on the call of five nonaligned leaders who indicated 3 weeks ago that if there wasn't progress on a comprehensive test ban, there could be increasing nonaligned opposition to extending the nonproliferation treaty? Do you have any sense of whether this is an added reason to go forth with a test ban at this time?

Senator MATHIAS. I think that is a very clear danger, that the Non-Proliferation Treaty will expire in 1995. In the foreseeable future, it is within the interests of the United States and the Soviet Union above all other nations to have the Non-Proliferation Treaty extended. Many small nations who have been induced to become parties to the Non-Proliferation Treaty will feel very little incentive to renew their membership in that club if the superpowers are not making any progress at all—even along such modest lines as are involved in this resolution.

So the stakes here are complex and they involve issues like nonproliferation which will only become increasingly urgent it seems to me.

Mr. LEACH. Thank you very much.

Mr. BERMAN. Thank you.

Mr. Udall.

Mr. UDALL. I thank you, Mr. Chairman. I have not joined the Republicans; I simply wanted to be close to Jim Leach who radiates wisdom and good will.

Mr. LEACH. A lot of good will.

Mr. Udall. The same with my friends around you.

The gentleman just asked the one question I had, and let me say that I am delighted the two of you would come over here and share your wisdom with us. I think this is a terribly important subject we are dealing with, and I am delighted to have your input.

I worry an awful lot about proliferation; I do not know whether we are going to get agreement with the Soviets on specifics on a broad range of things. But however that comes out, proliferation holds about as much danger to mankind as the superpower confrontation, and I was pleased to hear that you think there is a connection here and that Senator Mathias believes that action of this kind would be a step against proliferation.

Mac, you are not always the spokesman for the administration, maybe I should not ask you this; neither is Senator Kennedy.

Senator Kennedy. I was waiting for that one.

Mr. Udall. What has the President said or George Shultz said on this subject? Is there any reason to hope that passage by the Senate and the House would lead them to go after this negotiating tool and go to work with it?

Senator Mathias. Before I speak for the administration, let me just add a word in fairness to my hosts in Moscow 2 weeks ago, because they expressed the same concern about the extension of the Non-Proliferation Treaty that we have expressed here. They are very much aware that if there isn't progress that the Non-Proliferation Treaty is at risk. I think that it is a healthy thing at least that the danger is recognized on all sides.

I don't think, Mo, that there is any magic formula that is going to induce action on this, but I think that if the Congress will act forcefully and strongly, that it will cause the administration to review the bidding and to review its whole position on this subject.

Mr. Udall. This is one area where the superpowers, I think, have a common interest; this proliferation question. I think we ought to be desperately searching for common areas that we can build upon and certainly this is one of them.

Thank you, Mr. Chairman.

Mr. Berman. Thank you.

Ms. Snowe.

Ms. Snowe. Thank you, Mr. Chairman.

I would like to thank both Senators here today for their statements. In all respects, this is indeed an important issue.

I just would like to raise a couple of questions, and one is: Do you think that national technical means is adequate to verify either of these two treaties? As you know, the administration has concerns about verification and making sure that the Soviets are in compliance with either of these treaties. That is why they have objected to going ahead and ratifying them.

Could you address yourselves to that particular issue and whether or not if that you think that onsite inspection is important or isn't important to the verification of these treaties?

Senator Kennedy. If I could, the most recent information on the verifiability of testing came from the Livermore Laboratory. I might just read what Warren Heckvottle of the Livermore Laboratory stated, this is fairly recently:

"The Livermore Laboratories recognize a 90-percent confidence can be achieved in the 3- to 10-kiloton range with appropriate seismic stations." They estimate 15 to 30 stations. Everndon and Sykes, who have done a recent study in them the last year, believe that, "New seismographic techniques allow detection down to 1 kiloton." That was the result of studies that were done a year ago.

During the previous administration, in 1979 during the negotiations that were held with the Soviet Union, there was near agreement on a treaty. I hope that perhaps the committee will have a chance to review where the two parties were when those negotiations were actually interrupted. There were tentative agreements, concerning both onsite inspection, and two, the placing of seismographic stations in the Soviet Union.

As you are aware, under the 1976 treaty, there is the opportunity for onsite inspection with regards to certain types of activities, That was the first time that that concept was agreed to. That is a very major breakthrough. It is the first time that the Soviets have ever agreed to it, and a position which the two parties were at in 1979 during the negotiation over a comprehensive test ban agreement in Geneva. It permitted both onsite inspection and seismographic stations.

Given not only where the state of the art was then but now, I believe a very strong case can be made in terms of the adequacy of verification. That would certainly be an issue that would be considered.

Ms. SNOWE. So you think that we should place seismic stations?

Senator KENNEDY. For the comprehensive test ban you would have to. I think most of them feel that seismographic stations would be much more effective in determining that rather than onsite inspection. I think most of the professionals agree with that.

Senator MATHIAS. In addition, the treaties contemplate that there would be some exchange of data which would enhance our ability to interpret whatever raw material we have. There would be an adequate verification capability.

Ms. SNOWE. Finally, one question. As you know, the administration released a study recently of Soviet violations, and they indicated that there might been a likely violation under the Threshold Test Ban Treaty. What is your response to that?

Senator KENNEDY. Congresswoman, I had mentioned before that scientists at the Livermore Laboratories find that the Soviet explosions are consistent with the treaties. There is a division between the two principal laboratories on this issue, and the DARPA, which is the acronym for the Defense Department's Advanced Research Projects Agency, in their working group's first draft have indicated that their conclusions are consistent with the Livermore Laboratories. I think that is where the technology is at the present time. I am sure that the committee will want to get those reports or at least those kinds of assessments on it. I found that the information provided by Livermore was quite convincing. But that would have to be something that will be reviewed.

Ms. SNOWE. Thank you.

Senator MATHIAS. There was a qualification in the reference to the violation. It was, I believe, a "likely" violation.

Senator KENNEDY. This gets very technical in terms of the nature of the conditions of the test site. If it is interpreted to be composed of certain components, then the tests could be perceived as being a violation of the treaty. If it was composed of other components, it would not be considered a violation. This gets into an area of technicality that I think you would have to be resolved in in your own mind, but I think it is evident now that scientists at the two laboratories themselves and other experts are divided on it.

Senator MATHIAS. I think that is the key point; that the Joint Chiefs looked at this at the time the President signed it; they knew all about the factor of two; that any reading you got off the seismograph might be either half of what you read or double what you read. The Joint Chiefs advised the President to go forward that notwithstanding.

Ms. SNOWE. Thank you.

Mr. BERMAN. Thank you. I think I will just ask a couple of my questions at this point.

Just on that last point, just to make sure that we all understand. This regards a debate about an explosion with respect to whether it violated the terms of one of the unratified treaties?

Senator KENNEDY. That is correct.

Mr. BERMAN. Secondly, Senator Kennedy, just again to clarify, I thought I heard you say that with respect to verification of a Comprehensive Test Ban Treaty, we would need in-country stations?

Senator KENNEDY. That is correct, Mr. Chairman. The negotiations in 1979 were at a stage where the Soviet Union had agreed to the placement of what was being considered to be sufficient numbers, from both the Joint Chiefs point of view and from the NSC point of view for meeting that particular requirement.

Mr. BERMAN. Didn't they also agree in the treaty that was concluded, the most recent of the two nonratified treaties?

Senator KENNEDY. The 1976 treaty. Onsite inspection under certain conditions.

Mr. BERMAN. OK. An issue that I am confused about: If the Senate were to ratify those treaties, is it a ratification from which a legal obligation not to test above the threshold flows, or is it a ratification which conditions the legal obligation on working out the details of the verification?

Senator MATHIAS. I think that ratification would complete the process of negotiation. Of course, you would spin that out if you put reservations into the instrument of ratification, or if you attached a protocol of some sorts. There really is no absolute answer to your question except that ratification is, generally speaking, the ultimate step in the completion of the process.

Mr. BERMAN. So there were not issues in those treaties that were left open for subsequent negotiation and on which the obligations would be conditioned? The only condition would be one if the Senate imposed it in the ratification.

Senator MATHIAS. If the Senate would now say, "All right, we will go ahead and ratify but, because of intervening factors, are going to add reservations."

Mr. BERMAN. Thank you.

One final question. In your discussion, Senator Mathias, of the position of the Soviets, I heard you discuss their pessimism with respect to the talks about to commence in March. I was unclear about what their discussions were with you with respect to a Comprehensive Test Ban Treaty.

Senator MATHIAS. Most of our discussions dealt with the prospects in Geneva. It is my general impression that they would welcome an opportunity to resume negotiations on a Comprehensive Test Ban Treaty.

Senator KENNEDY. I would just mention, I am not interested in looking back, Mr. Chairman, but we were the ones that terminated those particular negotiations, unlike the other agreements.

Mr. BERMAN. Mr. Solarz.

Mr. SOLARZ. Thank you very much, Mr. Chairman.

Does either of you know whether the United States has been testing weapons with a yield of over 150 kilotons underground?

Senator KENNEDY. Testimony to the Armed Services Committee is to the negative.

Mr. SOLARZ. Do you know, Senator, how long we refrained from testing over that 150 kiloton limit?

Senator KENNEDY. I believe since the signing of the treaties; before that, I could not say.

Mr. SOLARZ. Now what about the Soviet Union; do you have any information as to whether or not they have been conducting tests with a yield of over 150 kilotons underground?

Senator KENNEDY. That is the point where there is some difference. They have had significant tests of significant kiloton capability and that is where there is a division within the intelligence and defense community of whether they have exceeded the threshold or not.

Mr. SOLARZ. I can understand the reasons for a Comprehensive Test Ban Treaty which would prohibit all testing. The advantages seem fairly self-evident. But it is not fully clear to me what the advantages are of a treaty that prohibits testing above 150 kilotons if it permits testing below that level. I wonder if either or both of you could speak to what you could consider to be the technological, military, or other advantages which would accrue as a result of the ratification of these treaties which would prohibit testing above 150-kiloton yields, but which would permit testing below that level.

What do we gain by actually ratifying such a treaty? In other words, if they can test something at 140 kilotons, what have we gained if we prohibit them from testing something underground that might be 180 kilotons or higher? Are there any environmental, health, safety, military, technological, or other advantages?

Senator KENNEDY. I would say first of all, Mr. Chairman, as you probably know in terms of our own technology, the capability of developing new multimegatonnage weapons is increasingly both available to the United States. You would have to assume it is to the Soviet Union. This obviously puts some limitation in terms of the development of potential megatonnage weapons systems which the Soviet Union has been more inclined toward than the United States in the past, but which we have now very substantial capability of developing.

So I suppose that what you are talking about is limits on very high yield weapon systems, and I think it is, as so many others, actions that are taken, it is a small step but not unmeaningful. I would not draw enormously significant conclusions, but I do think that the fact that we would ratify it at this particular time would be helpful in our move toward a comprehensive test ban.

These flow together; all three approaches flow together in limiting the arms race that there is a consistency in terms of both the ratification of the signed treaties and indication of willingness to move forward on a comprehensive test ban.

Mr. SOLARZ. Let me approach it, for a moment, from a political point of view. To what extent do you think our failure to ratify treaties we have aleady negotiated compromises our capacity to successfully negotiate future agreements; because if our credibility as interlocutors is diminished, the Soviet side may be less willing to make concessions for which they have no assurance, even if our negotiators accept them, that the Senate will approve them by ratifying the treaty.

Do you have any sense that our failure to ratify these treaties has created that kind of problem?

Senator MATHIAS. The problem has already existed. The lack of confidence has been a major handicap in relations between the United States and the Soviet Union. And that lack of confidence goes to all kinds of activities; not just arms control and security questions, but all kinds of activities.

The fact that we negotiate treaties and then fail to ratify them, fail to put them into full effect, exacerbates the confidence problem, or the lack of confidence problem, to be more exact. I think that from an international point of view, it would be viewed as a positive sign if we would proceed to ratify these treaties, and with respect to your question "what good is it?" if it allows at least some kind of small-scale testing, I would say it is not 100 percent, obviously, but it does impose some restraint; it does put some curb on large-scale, sophisticated new weapons.

Mr. SOLARZ. I do not want to be seen as arguing against the ratification of these treaties which I very much support, but I did——

Senator MATHIAS. It is a valid question.

Senator KENNEDY. I think the Executive would probably be better able to respond to it than we.

Mr. SOLARZ. Let me ask you both one final question, which relates only tangentially to these two treaties, but which I think does involve larger questions upon which I would be interested in getting your views. That is, if anything is worse than not ratifying a treaty that has already been negotiated, it is obviously breaking the terms of the treaty which has been ratified.

We now appear to have some fairly persuasive evidence that the Soviets have violated a number of previous arms control agreements that have already been negotiated, in particular, there are some serious allegations concerning their insipient violation of the ABM treaty through the construction of a phased array radar in a place where it was not supposed to be, the allegations concerning encryption of data, and the like.

My question would be, to the extent that we believe these violations have taken place, on what basis do we either ratify previously negotiated agreements or enter into new agreements without first insisting that these violations be cleared up in a satisfactory fashion. In other words, if these violations have taken place, and if we proceed to ratify treaties and negotiate new ones without receiving satisfaction with respect to these violations, are not we in effect sending a signal to the effect that the Soviets can violate their obligations at will without having to pay a price for doing so?

I would be interested in how you would justify proceeding with the ratification of these treaties in light of the allegations that have been made concerning Soviet violations of other treaties.

Senator MATHIAS. Well, you are correct that there are allegations, and of course they are denied on the other side. There is a considerable amount of work that has to be done to ascertain what the true facts are. By the same token, the Soviet Union is pointing the finger at the United States in some particulars, that we in fact have violated some of our obligations.

What we have to do, of course, is not to depend on their good will or their good intentions. We have to depend on the best means that are possible to verify whether or not there is compliance. The fact that these instances—these allegations as you call them—exist is a perfect illustration of how difficult it is to be absolutely sure in each question. We have to do the very best we can.

Mr. SOLARZ. Do you dispute the accuracy of the allegations, then?

Senator MATHIAS. Well, Senator Kennedy has just pointed out that it is not a question of either his disputing or my disputing, but serious scientists in this country are in dispute among themselves.

Senator KENNEDY. There is no question that over the length of these treaties there have been allegations both by the Soviets and by the United States. Over a period of time some of those have been brought to the standing committee.

Some of those allegations were made against the United States when we were reconditioning certain of the Minuteman missiles—and we had various coverings of the missile sites in North Dakota which made it difficult for them to detect what we were actually doing at that particular time. We put coverings on because of weather conditions and, after they complained, we dismantled those.

As a technical violation, that was a violation. We have had the similar kinds of things with regard to Soviet pens, and the construction of various kinds of Soviet submarines. We have had a long list which has been submitted publicly—declassified by the President of the United States.

I am not here today to go through various aspects of it. I think clearly there have been violations. I think the most notorious one is the radar system, which is a violation of the ABM treaty. I think even though it has not been made operational, there is every indication that there has been a violation.

I think in dealing with those, or talking about that, we have to consider whether the violations do really undermine the basic, overall agreement. And if they do then I think it is of a very serious, compelling, and overriding nature.

We have had General Ellis appear before the Armed Services Committee to discuss the violations. When he was asked, given the list of violations that has been put out by the President of the United States, did he feel that those were sufficiently serious that would warrant the abrogation of those treaties, his response was to the negative.

I think there is no question that the establishment of that particular radar with all of its implications that it could have in terms of a defensive system, is enormously troublesome.

I would also point out, however, that we are setting a course if the SDI program is actually implemented, where we are saying to the Soviet Union: We have not broken out of that treaty yet. But as soon as we deploy the first system out, we will effectively have broken out of ABM.

So we are going to go to the Soviets, to Geneva and say: You are violating the ABM treaty with your radar system out there; we are moving, as Secretary Weinberger has said, full bore on research on SDI, which is also going to include tests, and we will in other words be prepared to break out at a time when we are going to move through the testing.

Now, I do not hold any brief for the Soviet Union, and there is no question that there have been violations—but I think we have to be consistent or we are going to be hard-pressed to make a very strenuous case, certainly with regards to the ABM treaty.

I think the situation is different with regard to chemical weapons; I think it is entirely different with regard to human rights. I think in those cases there have been responses by the Soviet Union which I think are completely inadequate, and completely inconsistent with the agreements.

Mr. SOLARZ. With respect to the ABM treaty, if we came to the conclusion that the radar installation clearly constituted not only a violation, but a serious violation, what do you think we should then do?

Senator KENNEDY. Well, as I say, I would certainly hope that these would be issues in these negotiations, and the radar is not going to be operational for a 2-year period. But I do not think there is any question that it is a violation.

Senator MATHIAS. Then it seems to me our course is very clear, and it is provided for in the process. The standing Consultative Commission exists to arbitrate these kinds of problems, and the first thing we ought to do is to go there. Now, if you cannot get it resolved there, then you move to the next step; but that is the first step that you take, to the Standing Consultative Commission.

Mr. SOLARZ. Right. I fully agree with you, Senator, but I am asking, at the end of the day what do we do if we are convinced a serious violation has taken place and the other side refuses to acknowledge or correct it?

Senator KENNEDY. I have no easy answers, Congressman, I asked the same question of Mr. Perle and the Joint Chiefs the other day, and there was silence on their part, as well.

Senator MATHIAS. Ultimately you come to the end of the road on such questions, if it is of that level of seriousness.

Mr. SOLARZ. I think, and I will conclude on this point; I think there is an answer to it. I think at the end of the day if we believe there is a serious violation which cannot be resolved through established procedures, and we make a national determination that the Soviets have not lived up to their commitments and are willfully violating the terms of the treaty, at the very least, we have to take the position that we are no longer constrained by the terms of that particular treaty, either.

Additionally, I think we would have to consider whether we should remain constrained by other treaties, if we are dealing with people who literally cannot be trusted on matters of such overriding national importance.

Senator KENNEDY. At the end of our resolution: In accordance with international law, the United States shall have no obligation to comply with any bilateral arms control agreement with the Soviet Union if the Soviet Union is violating. So that is included, and that certainly was a part of our resolution, and you do not have any argument with us, Congressman, with that kind of conclusion.

I think the question is, what is the nature of the violation; how serious it is with regards to the violation. This is a serious one. Whether it reaches that threshold is something that would have to be given very serious thought.

Mr. BERMAN. There being no more members of the Foreign Affairs Committee walking through the door, Senator Downey.

Mr. DOWNEY.[1] Thank you for the promotion.

Senator MATHIAS. I am glad you think it is a promotion.

Mr. DOWNEY. Or demotion, depending on——

Mr. BERMAN. It was a slip.

Mr. DOWNEY. I just have a couple of questions, and I want to thank the chairman and the members of the subcommittee for allowing me to ask our esteemed guests some questions.

Senator Mathias, in your years in the Senate observing the Soviets, have you ever found it productive to go public first with ideas about violations before you bring things to the Soviets in terms of resolving problems between us?

Senator MATHIAS. There has been a fairly extensive record established by the Standing Consultative Commission. It was established for low-key and confidential handling of such problems, at a level where they can be discussed with candor and openness and in the absence of a lot of political oratory, and it seems to work better.

Mr. DOWNEY. Senator Kennedy I think pointed out a number of instances where the standing consultative committee had been consulted with respect to missile covers, both with respect to the SS-11's in the Soviet Union and the Minuteman here, which was quite an effective way to deal with the problem; and both sides complied very quickly.

I have a little bit more provocative question for you, Senator Mathias. Would you be as anxious to support this treaty if the President sent it to us as an executive agreement?

Senator MATHIAS. Well, I do not think I would have any less enthusiasm for it as long as the other side was equally happy with it.

Mr. DOWNEY. The reason I ask, and I do so because I am very troubled by the fact that notwithstanding our Founding Fathers, and notwithstanding the fact that I am not a Member of the U.S. Senate that gets to participate in treaty negotiations, that given the lengthy history of the recent postwar history of the number of executive agreements that we have seen versus the number of treaties, and the fact that House Members would be particularly interested in being involved in this process, No. 2 and No. 3, the fact that there always seemed to be one-third of the U.S. Senate—and I do not mean to characterize your body or impugn any of the Members who are opposed to just about anything—that for purposes of actually seeing an agreement that an executive agreement affords us the opportunity to have both Houses of Congress participate and also allows not to be held hostage by 33 Members of your body.

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[1] Hon. Thomas J. Downey, a Representative in Congress from the State of New York.

Could you comment on that?

Senator Mathias. It was negotiated as a treaty, and I think we would have some difficulty in altering its character and nature. I have no institutional hangup as far as how we get it ratified is concerned and, generally speaking, in international law a treaty is ratified according to the constitutional process of each nation.

So it could be done that way. But I think having started as a treaty, we would have a hard time avoiding the clear mandate of the Constitution.

Mr. Downey. The reason I ask, and I am going to be quite candid with you: During the period of time when the SALT II Treaty was being negotiated, a number of the Members of the House who were SALT advisers had gone to the President and suggested that he was going to have difficulty with the SALT II Treaty as a treaty or as an agreement, getting it ratified and to explore the possibility of recasting it when he brought it back to the body, and as I understood it at the time, one of the biggest objections where they were concerned about some of the concerns that you would have, and that is the reason I put the question to you directly.

I want to thank you for your leadership on the issue.

Mr. Berman. Senators, thank you very, very much for giving us your time, and for your fine work in the Senate last year on this issue. Hopefully we will have something for you to deal with this year.

Congressman Berkley Bedell will testify on his legislative proposal, House Joint Resolution 3, and along with that testimony, our own subcommittee colleague, Jim Leach, will make a statement. He is the cosponsor of this measure. And, of course, my friend and colleague from California, Barbara Boxer, is going to testify on House Joint Resolution 119, the nuclear test ban challenge.

We are very honored to have you before our subcommittee, Congressman Bedell. Would you care to start?

STATEMENT OF HON. BERKLEY BEDELL, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF IOWA

Mr. Bedell. Thank you, Mr. Chairman. I appreciate this opportunity to testify. I would like to submit written testimony, together with other printed materials, for the record and speak from my notes.

Mr. Berman. The record will be held open for that.

Mr. Bedell. Several points I wish to make have already been made quite clearly. For that reason, I will try to abbreviate everything as much as I can.

The nuclear arms race is one of the most pressing problems confronting the people on our globe and I believe the comprehensive test ban treaty represents a sensible, realistic approach toward bringing this problem under control.

I appreciate tremendously the work that Jim Leach, my colleague from Iowa, has contributed in this effort, and it is a great pleasure to work with him on this proposal.

House Joint Resolution 3 is the exact proposal that Senators Kennedy and Mathias have already testified to. It is identical to the proposal that was passed in the Senate by, as they mentioned, by an overwhelming vote of 77 to 22.

As has already been indicated, world leaders have long supported a comprehensive test ban treaty. Such an approach has been supported by every administration from Presidents Eisenhower through Carter. Indeed, past ratified treaty commitments obligate us to proceed toward negotiating such a treaty.

The preamble to the Limited Test Ban Treaty states the signatory nations will seek, and I quote, "to achieve the discontinuance of all test explosions of nuclear weapons for all time."

The Nuclear Non-Proliferation Treaty of 1968 reaffirms in article VI a mutual superpower commitment to, and I quote, "pursue negotiations in good faith on effective measures relating to the cessation of the nuclear arms race at an early date."

We have ratified each of those treaties, Mr. Chairman. They, therefore, are the law of the land. I believe we should expect the people of our country to obey the laws of our land; we also should expect our Government to obey those laws.

We have been flooded recently with a large number of my people from rural America where we have serious agricultural problems. Many of us believe very strongly that no small part of that problem comes from the tremendous budget deficit we have and the tremendous amount of military spending that is contributing to that deficit.

Certainly, if we could take steps to bring defense spending under control, we would also take important strides toward the problems that confront rural America, as well as moving toward a more peaceful world where our people, and all people, would have somewhat less worry about the possibility of making this planet actually uninhabitable.

Equally important are the dangers of the proliferation of nuclear weapons to more and more nations on our globe. The Nuclear Non-Proliferation Treaty that has been mentioned will be reviewed this September for the third time by the 127 nations who are signatories to that treaty, and they rightfully say, "Why should we continue to abide by this treaty if the Soviet Union and the United States are not abiding by their commitments to this treaty," which commitment was that we would pursue negotiations toward a comprehensive test ban treaty.

In my opinion, superpower failure to negotiate a comprehensive test ban jeopardizes the continued adherence of those countries to abide by the Non-Proliferation Treaty and it certainly makes it more difficult for us to get other nations who have not yet signed the Nuclear Non-Proliferation Treaty to join in endorsing the provisions.

House Joint Resolution 3 is not a complicated bill. It simply calls the submission of a threshold test ban of peaceful nuclear explosion treaties to the Senate for the purpose of consent to ratification and for the President to propose to the Soviet Union the immediate resumption of negotiations toward the conclusion of a verifiable comprehensive test ban treaty.

We already prohibit testing of underground explosions up to 150 kilotons. We have heard arguments here as to whether or not the Russians are exceeding that limitation. I would point out that it is much easier to verify and confirm a complete ban on testing than it is to argue about whether we or they have exceeded 150 kilotons or whether we or they have not exceeded that limit.

In addition, I hope it was clearly understood that the previous comprehensive test ban negotiations that were conducted by the Carter administration called for the installation of specially equipped tamper-proof seismic stations in the Soviet Union, and limited onsite inspection of testing facilities.

It is estimated current seismic technology coupled with our national technical means of verification allows us, with high confidence, the ability to verify down to as low as 1 kiloton. One of the concerns that some have had is the verifiability of the treaties and whether the Soviets have cheated on the Threshold Test Ban or Peaceful Nuclear Treaties. Upon ratification, of these treaties, a seismic data base exchange for the purposes of enhanced verification takes place, and onsite inspection of the peaceful nuclear explosions would be permitted.

Let me read from House Joint Resolution 3. It says:

> At the earliest possible date, the President of the United States should request advice and consent of the Senate to ratification, with a report containing any plans the President may have to negotiate supplemental verification procedures, or if the President believes it necessary, any understanding or reservation on the subject of verification which should be attached to the treaty.

That applies to the Threshold Test Ban and the Peaceful Nuclear Explosions Treaty. That amendment was added in the Senate.

In addition, it has already been pointed out, that this measure also says that, "in accordance with international law, the United States shall have no obligation to comply with any bilateral arms control agreement with the Soviet Union that the Soviet Union is violating."

Another argument that has come up against CTB negotiations is that we have to test weapons in order to be certain that our arsenal is operable. I think this is absolutely ridiculous, Mr. Chairman. I hope we will remember that such a treaty applies equally to both sides. I, personally, don't know what could be better than for neither side to have confidence in the operational capability of their nuclear arsensals. It sure would discourage a first strike.

The argument has constantly been made that the Soviets are rapidly catching up with us. Under those circumstances, I can't see what would be more beneficial to our national security interests than a comprehensive test ban that stops the Russians where they are at.

During the 98th Congress, House Joint Resolution 3 was cosponsored by 127 Members of the House. We already have 93 cosponsors at House Joint Resolution in this Congress. Considering the importance of controlling the proliferation of nuclear weapons to other nations, and considering the importance of taking the first step toward bringing the nuclear arms race under control, I believe it is time for the House to act on the merits of House Joint Resolution 3, and I hope we can do so at the earliest possible date.

[Mr. Bedell's prepared statement follows:]

PREPARED STATEMENT OF HON. BERKLEY BEDELL, A. REPRESENTATIVE IN CONGRESS FROM THE STATE OF IOWA

Mr. Chairman, I would first like to thank you and the members of the subcommittee for permitting me this opportunity to appear before you today to begin what I hope are a series of hearings leading to final passage of House Joint Resolution 3. I would also like to commend you all for your continuing attention to what I consider to be the most urgent issue confronting the Nation-- that of effective alternatives that can be taken to enhance the national security interests of the United States through placing an end to the dangerous nuclear arms spiral in which both we and the Soviets have been engaged since the end of World War II.

On January 3rd, my colleague and fellow Iowan Jim Leach and I reintroduced House Joint Resolution 3-- a measure to prevent nuclear explosive testing. If adopted, this proposal would require the President to submit the Threshold Test Ban [TTB] Treaty of 1974 and the Peaceful Nuclear Explosion [PNE] Treaty of 1976 to the Senate for consent to ratification, as well as to propose to the Soviet Union the immediate resumption of negotiations toward the conclusion of a verifiable Comprehensive Test Ban [CTB] Treaty.

The importance of this issue cannot and should not be discounted. During the 98th Congress, House Joint Resolution 3 received widespread bipartisan support in the House and was cosponsored by 127 of our colleagues including yourself and sixteen other members of this Committee. Its exact counterpart in the Senate-- Senate Joint Resolution 29-- also received the solid bipartisan support of thirty-nine Senators and was approved later in the form of an amendment to the FY-85 Defense Department Authorization bill expressing the sense of the Senate that its recommendations be made an element of United States arms control policy efforts.

Under your leadership, this Committee requested comments from the Department of State relating to House Joint Resolution 3. In response to your inquiries, Assistant Secretary of State Tapley Bennett specified that "a comprehensive test ban continues to be a long-term objective of Administration arms control policy." Nevertheless, despite the importance of this "long-term objective," Secretary Bennett went on to say that "the United States does not intend to pursue negotiations toward a CTB" (I have included this letter with my statement). I would also like to point out that during his confirmation hearings, our former colleague and now Deputy Director at the Arms Control and Disarmament Agency, David F. Emery, noted that ratification of the Threshold Test Ban Treaty "would be in the best interest of our country." He went on to say that "if we go ahead and ratify and then work to improve the verification... we will demonstrate that when the United States puts its good name on the line for a treaty of significance, it can be counted on to follow through." In its present form House Joint Resolution 3 would permit improvements in verfification and in my view, is in the best interests of the country.

Mr. Chairman, the implementation of a verifiable comprehensive test ban treaty has been supported and pursued by every President from Dwight D. Eisenhower to Jimmy Carter. While I completely share the Reagan Administration's desire to successfully achieve this "long-term objective," I fail to understand its reluctance to enter into a negotiations process aimed at the accomplishment of this important national security objective. President Kennedy once told us that we should never negotiate out of fear nor should we fear to negotiate. Why then are we so apparently afraid to enter into comprehensive test ban negotiations at this time? It may very well be a question of marshalling the political will necessary to conduct such negotiations. One of the primary purposes of House Joint Resolution 3 is the creation of a climate in which the political will to negotiate a verifiable comprehensive test ban treaty on both sides becomes a reality.

Mr. Chairman, I mentioned the Senate's overwhelming adoption and inclusion of House Joint Resolution 3's counterpart [Senate Joint Resolution 29] in the form of an amendment to last year's Defense Department Authorization bill. Unfortunately, House germaneness rules prevented us from similarly expressing the sense of the House that the actions recommended in each of these proposals be taken. This year, House Joint Resolution 3 has been reworded to include two revisions that were adopted by the Senate in the form of amendments to the FY-85 Defense Department Authorization bill which embodied the language of Senate Joint Resolution 29. In my view, these two changes strengthen the arguments in favor of our formal approval of House Joint Resolution 3 such that both the House and Senate are in agreement with respect to the issue of nuclear explosive testing.

The first change allows the President the opportunity to submit "a report containing any plans the President may have to negotiate supplemental verification procedures, or if the President believes it necessary, any understanding or reservation on the subject of verification which should be attached" to either the Threshold Test Ban or Peaceful Nuclear Explosion Treaties. This step allows the United States the unique opportunity to take advantage of the extraordinary instruments of verification that were included within these treaties, as well as to express to the Soviets our legitimate concerns over any testing irregularities we have associated with these treaties since we signed them. Thus the President would be in the position to enhance the national security benefits of each of these treaties to the United States, as well as to explain to the Soviets in greater technical detail the additional procedures he believes necessary to compliment the verifiability of these treaties.

The second change expresses the sense of both the House and the Senate that "in accordance with international law, the United States shall have no obligation to comply with any bilateral arms control agreement with the Soviet Union that the Soviet Union is violating." Thus, the costs of any real or potential treaty violations are spelled out. The Soviet Union is put on notice that the United States will pursue such negotiations in good faith and will abide by any treaty agreement that is reached, so long as the Soviet Union complies with the letter and intent of any such treaty agreements.

The United States is a nation of laws. We regard ratified treaties as the law of our land. At the same time, however, we have in recent years acquired a reputation of being willing to negotiate agreements that we later fail to adopt and ratify as laws of our land. No treaty agreement is perfect, but our failure to ratify the Threshold Test Ban and Peaceful Nuclear Explosions Treaties feeds Soviet suspicion and mistrust over our intentions. The Soviets point to our failure to ratify these agreements as justification for their continued and relentless buildup of newer and more lethal nuclear weapons systems, and although we readily announce our intentions to abide by the commitments made in each of these sets of negotiatins, the Soviets remain leery of the sincerity of our commitment and more readily willing to stretch to the outer limits their own commitment and compliance with these agreements.

Ratification of the Threshold Test Ban and Peaceful Nuclear Explosion Treaties-- including any supplemental verification procedures the President may want to add to those treaties-- offers the United States a splendid opportunity to demonstrate to the Soviet Union and the world the sincerity of our commitment to arms control through formal adoption of these treaties as part of the law of our land. At the same time, the United States is in a more secure position to evaluate better the sincerity of the Soviet Union's commitment to these treaties through the instruments of verification that are secured through treaty ratification.

These gains in verifiability are indeed significant. You may recall that during the process of Threshold Test Ban, Peaceful Nuclear Explosion and subsequently, Comprehensive Test Ban Treaty negotiations, the Soviet Union agreed in principle to several United States demands that were aimed at ensuring Soviet compliance with the terms of these treaties, as well as enhancing their verifiability. These demands included a prohibition on all peaceful nuclear explosions; the establishment of a geological data base; the detonation of two nuclear explosion tests for calibration purposes to compare U.S. and Soviet monitoring equipment; limited on-site inspections; and, the installation of specially-equipped, tamper-proof seismic stations on Soviet territory. It seems to me that such verification procedures are in the best long-term national security interests of the United States and its allies, particularly during an era of increasing U.S.-Soviet tensions, transitional Soviet leadership cycles, and what appears on both sides to be yet another round of the nuclear arms race.

I also believe it is in the best long-term national security interests of the United States to propose to the Soviet Union the resumption of Comprehensive Test Ban Treaty negotiations. We have already initiated such steps by adopting and ratifying of the Limited Test Ban Treaty of 1963 and the Nuclear Non-Proliferation Treaty of 1968. Each of these documents include mutual superpower commitment to the achievement and implementation of a CTB treaty. The preamble to the Limited Test Ban Treaty specifies that each party will seek "to achieve the discontinuance of all test explosions of nuclear weapons for all time." Article VI of the Nuclear Non-Proliferation Treaty states that each party to the treaty "undertakes to pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament." These treaty obligations manadate a joint U.S.-Soviet return the CTB negotiating table. In addition to the U.S. national security benefits that are served by this return, I would also like to point out that the resumption of these negotiations now serves mutual superpower commitment and interest in preventing the further proliferation of nuclear weapons technology throughout the global community.

In September of this year, the Nuclear Non-Proliferation Treaty comes up for third review. Many experts have noted their concern that several non-weapon states may be on the verge of breaking away from this treaty as a result of what they consider to be superpower intransigence toward their obligation to pursue comprehensive test ban negotiations. What better signal could the superpowers send to the global community of the sincerity of their commitment to nuclear arms control, as well as their mutual disinterest in weapons proliferation, than the resumption of comprehensive test ban treaty negotiations? As we are currently engaged in multilateral discussions at the Conference on Disarmament in Geneva, in both a technical-level ad hoc Group of Scientific Experts and in the Nuclear Test Ban Working Group, such steps would seem to be most readily available to us.

Today, despite the resumption of other ongoing U.S.-Soviet arms control negotiations, deep fear and mutual distrust of one another's intentions threatens to break down the negotiation process that has been conducted between the United States and the Soviet Union since the dawning of the nuclear arms race. As I have stated, a new and even more destabilizing round of the arms race is now in its infant stages. This particular round threatens to be almost wholly unverifiable. In my opinion, the successful conclusion of a verifiable comprehensive test ban treaty would help to stave off this next round of the arms race, and serve as a starting point from which deep reductions in the world's nuclear arsenal could be scored. The successful conclusion of an enforceable and verifiable comprehensive test ban treaty would also help the United States in arguing its case against the further proliferation of nuclear weapons to non-weapons states. Clearly, such goals are in the best common interests of the both the United States, the Soviet Union, as well as all mankind.

House Joint Resolution 3 represents a modest proposal that will help the United States in implementing an arms control policy that helps to accomplish this common aim. Because it builds upon past negotiations, the Soviet Union will be more at ease in and understanding United States intentions. Because it pursues through negotiation the objective each side has sought to seek in the past, treaty negotiations could take place in an amicable environment with a minimum of distrust on either side of the negotiating table. Because such negotiations remain a long-term objective of United States arms control policy, there can be no better time than the present to resume them.

The conclusion of a comprehenive nuclear test ban treaty represents the most readily achievable and securely verifiable arms control agreement between the superpowers. A complete cessation of all nuclear weapons testing would serve to restrict both quantitative and qualitative improvements in nuclear weapons programs and development. A complete cessation in nuclear weapons testing would also restrain ongoing and subsequent Soviet nuclear force remodernization efforts, and prevent any dramatic breakthroughs in Soviet development of newer and more lethal nuclear weapons technologies. A complete cessation in nuclear weapons testing would also reduce, over time, each side's confidence in the reliability of their present nuclear arsenals and thus, would serve to lessen the risk of nuclear war through accident or design during a period of crisis or confrontation. Clearly, such steps are in the best interests of the United States.

In closing, I would like to say that the issue of nuclear arms control and reduction is of paramount importance to United States and global security. Implementation of a verifiable comprehensive test ban treaty can be the first step toward the achievement of this aim. House Joint Resolution 3 offers us hope that we can truly begin to accomplish this vital task. For that reason, it remains my sincere hope that this Committee will look favorably upon our proposal and recommend its consideration by the House of Representatives as quickly and expedtiously as possible.

Mr. Berman. Thank you, Congressman Bedell.

Mrs. Boxer.

Mrs. Boxer. I wonder whether or not Congressman Bedell would like to have questions, because my bill is different, slightly different, and maybe it is time for Congressman Leach to make his comments. I will be happy to wait, because it is a different bill.

Mr. Berman. Congressman Leach, we will hear from you and then perhaps question both of you before we go on to Congresswoman Boxer.

STATEMENT OF HON. JIM LEACH, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF IOWA

Mr. Leach. Mr. Chairman, I have a lengthy statement I would like to request be put in the record.

Mr. Berman. Without objection, that will be done.

Mr. Leach. I would just like to make several very short observations.

First, it is always an honor to do anything with Berkley, who I consider to be the House's most thoughtful Member, with the strongest moral fiber, period.

Second, in terms of arms control, we miss the point when we don't recognize that some issues are not only important, they are time-sensitive. If we want to dilly-dally around about a test ban for another two decades, we are going to have 20 or 30 or 40 more nuclear powers, and it is nuts.

In terms of implications of East-West relations, we always look at things as the United States and the Soviet Union. We have been obsessed by it, and in many regards properly so, but there are a number of issues that apply to a host of other countries, and a test ban is clearly one of those, particularly because of the potential proliferation of nuclear capacity.

When the five nonaligned powers recently met to talk about a test ban, it was very interesting that one of the principal countries that is opposed to participation in a nonproliferation treaty, Argentina, has indicated that if a test ban is achieved, it may well change its position. That is very significant.

In addition, in the history of negotiators in arms control, there are only a few from the nonaligned world that stand out, and probably the most important is Ambassador Garcia Robles from Mexico, who is the architect of the not-so-famous Treaty of Tlateloco. In any regard, Ambassador Garcia Robles has made it very clear that he now opposes extension of the nonproliferation treaty because the nuclear powers have fiddled around to no serious avail.

It means in essence that we are, in terms of a test ban, not only wasting time but potentially wasting one of the most important achievements that has so far been achieved in the whole history of arms control, the NPT. My only hope is that as Congress looks at this, and we are behind the 8-ball because we have no authority to negotiate for our country, that we help at least start the process of serious thinking within the administration to rethink this very vital issue.

Thank you, Mr. Chairman.

[Mr. Leach's prepared statement follows:]

PREPARED STATEMENT OF HON. JIM LEACH, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF IOWA

Mr. Chairman, I am pleased to have the opportunity to make a short statement for the record on this important topic. There are few topics which we will be called upon to examine which could prove to be more crucial to the well-being of the generations to follow us upon this planet. Though I personally believe that much more stringent bilateral limitations on the testing of nuclear warheads should be an immediate priority of this Administration, whatever the outcome of these hearings, I think you should be commended for reopening the examination of this topic.

In this country, a comprehensive test ban treaty has been an objective held by every president since Dwight Eisenhower. In the 1960's, when the United States held a substantial superiority in the number of nuclear warheads possessed by the superpowers, President Kennedy worked to put a permanent end to nuclear testing, but was forced to settle for something less. These efforts resulted in the Limited Test Ban Treaty of 1963, in which the United States and the Soviet Union pledged to "put an end to the armaments race and eliminate the incentive to the production and testing of all kinds of weapons, including nuclear weapons, and achieve the discontinuance of all test explosions of nuclear weapons for all time [thereby ending] the contamination of man's environment by radioactive substances."

Similarly, in the Threshold Test Ban Treaty of 1974 the United States and Soviet Union stated that they "...shall continue their negotiations with a view towards achieving a solution to the problem of the cessation of all underground nuclear weapons tests."

Further restrictions on the testing of nuclear weapons were achieved with the signing of the Threshold Test Ban and Peaceful Nuclear Explosions Treaties. Two steps beyond the Limited Test Ban Treaty, yet short of a complete ban, these agreements are building blocks to the cessation of nuclear weapons testing. Collectively the Threshold Test Ban Treaty of 1974 and the Peaceful Nuclear Explosions Treaty of 1976 limit all underground nuclear testing to 150 kilotons.

Despite the fact that the Senate Foreign Relations Committee approved the treaties by a 14 to 1 majority, the agreements have yet to be taken up by the full Senate for ratification. Ratification of these agreements would be a logical and altogether appropriate starting point for future negotiations. While they are essentially small steps down the long road of arms control, these treaties are significant both on their merits and as a continuation of an ongoing process to ban the testing of nuclear weapons.

Perhaps the most important contribution these instruments will give to the cessation of the arms race is the substantial array of verification provisions embodied in the protocols to the agreements. Included in the TTBT and PNET are terms stipulating specific means of seismological data exchange and measures for on-site inspection of testing facilities. These detailed and unprecedented means of verification would, with treaty ratification, facilitate the monitoring of these limited agreements, and also serve as a partial precedent for verification of a CTB. In this regard, it is difficult not to be hopeful that even more on-site inspection can be negotiated in a CTBT, especially given the fact that just five days ago, the Soviet Union agreed to open some of its civilian nuclear facilities to international on-site inspection and suggested that such methods could be used to verify the observance of other arms control agreements.

Additionally, we would do well to acknowledge the concern of the international community and the potential relation between limitations on testing and the non-proliferation of nuclear weapons to other countries. Support for a comprehensive test ban exists worldwide. Since 1957, the United Nations General Assembly has repeatedly called for an end to all nuclear weapons testing. Subsequent to 1981, the United States has reversed its long standing position of supporting such measures by opposing or abstaining on the annual CTB resolution. Further, the United States has ceased encouraging CTB efforts at the Conference on Disarmament in Geneva. On May 22, 1984 and again on January 28, 1985, the national leaders of Argentina, Greece, India, Mexico, Sweden, and Tanzania called for a complete halt in the testing, production, and deployment of nuclear weapons. The six Presidents and Prime Ministers committed themselves to do everything in their power to facilitate agreement among the nuclear weapons states. Recognizing that arms control is not the responsibility of the superpowers alone, but rather is of vital importance for all countries, these leaders have given their full support to the United States and Soviet Union in an effort to restrain the nuclear arms race.

During the negotiations of the Non-proliferation Treaty of 1968, most non-nuclear states held that their renunciation of nuclear weapons should be accompanied by a commitment on the part of the nuclear powers to reduce their nuclear arsenals and to make progress on measures of comprehensive disarmament. Among the 124 signatories of the Nonproliferation Treaty, the United States, the Soviet Union, and Great Britain undertook - together with other signatories, "to pursue negotiations in good faith on effective measures relating to the cessation of the nuclear arms race at an early date."

In 1981, several signatory nations suggested that if the nuclear powers did not live up to their obligations under the treaty to pursue disarmament, particularly concerning the cessation of weapons testing, they would consider withdrawing from the NPT. This has important implications for the Nonproliferation Treaty Review Conference to be held in September of this year.

A comprehensive test ban would be a vital step toward ending the technological competition that is an impetus behind vertical and horizontal proliferation. The completion of this treaty would prevent the development of destabilizing weapons systems and discourage other countries from acquiring the capability to develop nuclear weapons. Moreover, completion of the agreement would somewhat ease the tensions in U.S. - Soviet relations and produce a more favorable climate for negotiation of reductions in nuclear arsenals, thus helping to reduce the incentive for development of first - strike offensive weapons.

It may be fair to say that the only obstacle to the completion of the CTB is lack of political will. But that will is gaining momentum, as is evident in the overwhelming support for the Kennedy/Mathias amendment to the 1985 Department of Defense Authorization bill. This measure, adopted in the Senate by a resounding vote of 77 to 22, expressed a sense of the Congress resolution that the President should submit both the Threshold Test Ban and Peaceful Nuclear Explosions Treaties to the Senate for ratification. Further, it declares that the President should propose to the Soviet Union the immediate resumption of negotiations for the conclusion of a verifiable comprehensive test ban treaty.

The momentum created by this amendment may be carried to the House of Representatives by House Joint Resolution 3, the purpose and content of which is embodied in the Senate action. House Joint Resolution 3 would solidify the signal to the President the concern of the American people that the nuclear arms race should and must be brought under control. I hope that the House will expedite this measure in the same manner as have our colleagues in the Senate.

Mr. BERMAN. Thank you. When Congressman Bonker led our delegation down to Argentina, we primarily focused on some trade issues, but we got into a long discussion on Argentina's position with respect to safeguards and the nuclear nonproliferation treaty. Bearing out the point that both of you have made, they were very, very strong and passionate on the whole issue of just who is doing the proliferating right now.

Perhaps the Argentine officials were speaking in response to the renewed discussion of SDI, the United States talking about proliferation in space and every other place. It would seem that that aspect of this issue is a very important one and cannot be overemphasized.

Mrs. Snowe, any questions?

Ms. SNOWE. Thank you, Mr. Chairman.

Congressman Bedell, certainly I want to thank you for your statement, as well, here today. I have several questions.

You mentioned the exchange of data. Do you think that we should establish procedures to insure the verifiability of the data that is being exchanged to determine compliance?

Mr. BEDELL. No. It is my understanding that upon ratification of those treaties it is agreed that there will be a technical data base between the United States and the Soviet Union. Whether or not anyone might question it, of course, is a possibility, but remember, these are military and scientific experts who are exchanging the data. As I understand it, one of the concerns we had with respect to this exchange was the quality of the seismological formation where testing occurred whether it was hard or soft. This data exchange allows us to determine better the status of these formations.

My answer would be that it seems to me that we are sure much better off if we have such an exchange of information between the superpowers not only for what it does in terms of confidence building and verification but what it accomplishes toward starting to move us away from our mutually confrontational attitudes that we seem to have at this time.

I think any exchange we can have between ourselves and the Soviet Union, whether it is students back and forth or whether it is congressional delegations or whether it is scientists or military experts, is very, very beneficial to our national security.

Ms. SNOWE. Do you support onsite inspection for a comprehensive test ban treaty and the other two treaties, or just for the comprehensive test ban treaty?

Mr. BEDELL. I think in the past it has actually been agreed upon by the Soviet Union that there could be onsite inspections of peaceful nuclear explosions and on the comprehensive test ban treaty if such inspections were required for verification.

Ms. SNOWE. To what extent do you think that the ratification of the threshold test ban treaty and the peaceful nuclear explosion treaty would detract from attempting to negotiate a comprehensive test ban treaty with the Soviets? To what extent would it detract?

Mr. BEDELL. It seems to me it would be quite the opposite. The way you climb stairs is to take a step at a time. The Soviet Union has a legitimate concern over the sincerity of our commitment to negotiate and follow through. Ratification of those treaties reaffirms our sincerity and builds confidence in comprehensive test ban negotiations.

I think ratification of those treaties demonstrates to the rest of the world and the Soviet Union that we are really serious in wanting to do something about the nuclear arms race. I think it is a tremendous step forward and as such I think it has more importance than, as Mr. Solarz indicated, whether it is important to stop 150 kiloton explosions as compared to 160 kiloton explosions.

Ms. **Snowe**. As you know the administration has been concerned about the verification process under the threshold test ban treaty and attempted to open those negotiations with the Soviets once again and they have refused.

Do you think that is legitimate on the part of the Soviets not to reopen those negotiations, since this administration has those concerns?

Mr. **Bedell**. I don't suppose that it is really legitimate for anybody to refuse to negotiate, any more than I think it is legitimate for us to refuse to negotiate a comprehensive test ban treaty, but I hope the point is clearly made that if we are really concerned about verification, then what we ought to do is ratify these treaties because those treaties are much more verifiable ratified than they are unratified in that it provides for the exchange of technical data back and forth and for onsite inspection, and both the President and the Senate could attach reservations on verification to these treaties, thus, verification would be enhanced. It is also my understanding that they have said that they would negotiate supplemental verification procedures if we showed good faith by ratifying these treaties. They have gone forward and we have not. They say, "Look, we think it is time for you to take a step rather than us just to continue to step, step, step, without your doing so."

Ms. **Snowe**. With the Comprehensive Test Ban Treaty.

Mr. **Bedell**. No, no. The Threshold Test Ban and Peaceful Nuclear Explosion Treaties. If we ratify those treaties, we could open negotiations on a comprehensive test ban.

Ms. **Snowe**. Then they would be open to negotiations on verification.

Mr. **Bedell**. That is correct. That is what they have said.

Ms. **Snowe**. Thank you.

Mr. **Berman**. Mr. Solarz.

Mr. **Solarz**. Thank you very much, Mr. Chairman.

Mr. Bedell, do you know if there are any militarily significant reasons for testing a nuclear device with a yield of more than 150 kilotons?

Mr. **Bedell**. No, I do not know. Well, whether there is significance of testing any or only bigger than 150 compared to less than 150?

Mr. **Solarz**. Larger than 150.

Mr. **Bedell**. I do not know. I know that many of our nuclear devices are much larger than 150 kilotons, as you know.

Mr. **Solarz**. But for purposes for which one might test these devices, you are not sure.

Mr. **Bedell**. No, I do not know.

Mr. **Solarz**. I am not, either, but I am just genuinely seeking after the truth.

Mr. BEDELL. I don't think that is really the issue.

Mr. SOLARZ. Well, it might be.

Mr. BEDELL. In regard to those particular treaties, I think the issue is primarily whether we move forward in trying to negotiate and ratify treaties. If there is no significance to larger or smaller tests, it seems to me that is all the more reason for us to move forward and ratify them.

Mr. SOLARZ. I think you tried to prove too much on that point. It may well be that even though there is no military advantage to be derived from testing a device with a yield of over 150 kilotons, it would still be worth ratifying the treaty as a way of demonstrating our determination to continue with this arms control process and as a way of enhancing our credibility as interlocutors in it.

But surely if there were militarily significant reasons for testing above 150 kilotons from which the Soviets might derive advantages, that would constitute an additional argument for limiting tests under 150 kilotons, particularly if one concluded they were in a state of nuclear development where tests of over 150 kilotons were more important to them than to us.

This is total speculation, but I think it is worth pursuing this line of inquiry if only so we can determine what the facts are.

What is your own answer to the question I put to Senators Kennedy and Mathias about the implications for our willingness to ratify these treaties, of Soviet violations of other arms control agreements, if one concludes that these violations, in fact, have taken place and that they are serious.

Mr. BEDELL. I think Senator Kennedy pointed out that in the resolution we are talking about today, that the final paragraph reads as follows:

> In accordance with international law, the United States shall have no obligation to comply with any bilateral arms control agreement with the Soviet Union that the Soviet Union is violating.

It seems to me that says quite clearly to them that this is not a one-way street.

Mr. SOLARZ. As I read that, I think that is a very welcome addition, but as I read that it seems to be saying that if they violate a treaty we will no longer be bound by the terms of the treaty which they violate.

Mr. BEDELL. Right.

Mr. SOLARZ. But it doesn't say anything about whether we would or would not be bound by the terms of other treaties.

I gather it would be your feeling that if we catch them in a serious violation, we ought to, in effect, announce we are no longer bound by the terms of that treaty. But if there are other treaties which they haven't violated and we believe it is in our interest to maintain those treaties, then we should continue to respect them.

Mr. BEDELL. That would be my belief. I don't know if everybody would agree with it, but it seems to me that treaties are negotiated as separate instruments of which you have concern. We must take those concerns seriously, otherwise we would have no arms control in our world. I think we have violated some treaties ourselves. If neither side takes its treaty commitments seriously or if they persist in violating those agreements, arms control would grind to a halt.

Mr. Solarz. I don't think anybody would blame the Soviets if they abrogated a treaty on the basis of our having violated it first if they deemed that to be a serious violation.

Let me ask you a tougher question, and I have really just begun to focus on this myself and I have a lot of respect for you and the amount of time and effort you have devoted to this issue and I know how deep your commitment is, so I think your views are particularly important.

But it does strike me that in a certain sense the whole arms control enterprise depends on the notion that, first of all, whatever agreements we reach have to be verifiable. We all accept that premise because none of us is prepared to trust the Soviet Union on the basis of its record. It is not a nation that inspires much confidence. Nevertheless, because of the threat of nuclear weapons and the consequences of nuclear war, we all believe that the search for arms control agreements is a moral, political, and military imperative.

But I also think that sort of at the center of all this is the notion that precisely because the agreements have to be verifiable, that if they are verifiable, that in and of itself will be sufficient to deter either side from violating the agreement. Why would you violate an agreement if the violation can be detected, unless the violation of the agreement gives you such an instantaneous and immediate advantage which you can capitalize on, that it might be a sufficient inducement to do so.

So in a certain sense, built into the arms control enterprise is the notion that if we can get a treaty which is verifiable, we can be confident that both sides will respect the agreement because the verification procedures will enable us to know if the other side violates it.

Now, in view of the fact that there do appear to have been some serious violations, or if one came to the conclusion that there were serious violations by the Soviet Union of previous agreements, what would you say to the argument that if we have in fact established that the Soviet Union has willfully, in a serious—not a minor or a technical way—but in a serious way clearly violated previous agreements, then on what basis can we have any confidence that the Soviets will respect future agreements, even if verifiable, because the previous agreements were also verifiable, and yet in spite of that, were violated.

We know that we will respect the agreement. I have to confess I am not familiar totally with our track record, but my guess would be that, to the extent there have been American violations, they were more of a technical nature rather than willful. But how would you respond to the argument that if the Soviets clearly have in a serious way violated previous agreements, it is simply not wise or possible to enter into future agreements with them because they may just as easily violate those?

Mr. Bedell. That is a fairly easy question.

Mr. Solarz. I hope so.

Mr. Bedell. First of all, we ask ourselves whether it is in our best national security interest to proceed toward a verifiable comprehensive test ban by which people do abide.

Second, if we pass legislation that provides for a comprehensive test ban, and that legislation also says that if they violate the treaty we are no longer obligated to it, all we can do is gain. If it falls apart, it falls apart.

I think to me the question is: Do you try to do something that would appear to be in the best interests of both nations, and I think particularly in view of what Mr. Leach has said in regard to the nuclear nonproliferation treaty and where we stand if we don't move forward with that, that it is quite clear that you try to do what is in your best mutual interests.

When you and I enter into a contract, we enter into a contract because we think it benefits both of us, and if you violate it, then the contract is null and void, we don't have it, but that doesn't mean we shouldn't try to enter into a contract for the benefit of both of us.

Mr. Solarz. I think that is a very good answer, but I think you also have to add to that that it is assumed that there is no significant advantage from violating the treaty first. It is quite true that if they violate the treaty, whatever the treaty might be, and we are in a position to determine their violation, then we are no longer bound by the treaty and we can do what we were constrained from doing.

If there is no significant military or other advantage to be gained from having violated the treaty first, then I think your argument is absolutely accurate. If there is, however, a significant advantage to breaking it first, then the argument, depending on what the advantage was, might fall. Here I suppose we need technical testimony from people qualified to give it with respect to any particular treaty as to what the disadvantages or disabilities are that would be inflicted upon us if the other side violated the treaty first. If there are none, then I agree with you so long as we can verify the treaty and there is a chance it will be respected.

I want to also thank you for coming today. You have really been one of the leaders in this effort and I hope you don't mind my putting some of these pesty questions to you, but I really think it is important for those of us who are deeply committed to the arms control enterprise to raise some of the tough questions which are going to be legitimately asked of us, and I think we have to think through the answers and make sure they are satisfactory.

Mr. Bedell. I hope in your question you would include the time situation and how quickly anybody would benefit from violating such a treaty, because it is at least my understanding that such benefits would not accrue immediately and there would be time to counter such benefits. If you violate it and the other side is then no longer obligated by it, you are not going to gain any immediate advantage.

Mr. Solarz. That was implicit in the question, quite obviously.

Mr. Berman. It certainly is an interesting area to get into. I guess after Yalta we could have stopped right there. I don't know.

I think a subsequent witness, Ambassador Stoessel, will be testifying to some extent that he has concerns regarding a comprehensive test ban treaty, based on the prepared text that I have seen, one of the reasons being its consequence for the development of certain weapons systems, with some specific reference to Midgetman.

I hope I am not in any way misrepresenting the thrust of those comments in trying to summarize or paraphrase them. I was wondering if you or Jim could give your thoughts on the whole question of whether or not a comprehensive test ban treaty would preclude the United States and the Soviet Union from developing certain weapons. To what extent, obviously in some cases, do you think that may be good? But to what extent could there be the kinds of stabilizing weapons that advance the cause of peace, if there is such a thing?

Mr. Bedell. Can I answer that first?

Mr. Berman. Yes.

Mr. Bedell. First of all, it doesn't necessarily stop the procurement of delivery weapons systems. It does have to do with nuclear explosions and the development of new nuclear warheads therein.

The thing that makes me just plain mad about our military is that they always look at our situation and they don't ever look at the other side. If you are engaged in anything, you look at what the other side is going to do.

That is exactly what happened when we decided we were going to MIRV our weapons. We gained a temporary advantage that now works against us. The Soviet Union has bigger missiles than we do. They can put more warheads on them than we can, and we are moving into a situation where it is going to be much more difficult to control this situation. Our military, my contention is, only looks at what they want to do and doesn't look at what the other side is going to do in response to it. "That's a crazy thing to do."

If it is correct, as people have constantly testified, that indeed we wouldn't trade our arsenal for that of the Soviet Union, then what could be better than to say we are going to stop testing today and make them stop testing as well as ourselves. I think that is right. I think it would stop us from going forward with some of our new weapons systems but, by God, it is going to do the same thing to the Soviet Union.

Don't we want to do that? Isn't that in the interest of humanity and in the interest of our national defense, and isn't it in the interest of farmers who are getting killed because of the deficit. Doesn't it make sense to try to end the nuclear arms race?

I think somebody better speak up to some of these military people who are coming forth with that argument, and I just wish I could be here to do so when they testify.

Mr. Leach in speaking may be a little more calm than I am.

Mr. Leach. I think Berkley makes a profound point, and I personally believe that the particular argument he refers to defies credibility.

What we have developed over the last 25 years of testing is a series of weapons that have gotten smaller and smaller, and in some cases more explosive but in many cases also cleaner. In terms of the Midgetman or Minuteman or whatever system you are talking about, we have a number of options in already tested warheads that could be taken off the shelf.

It happens that the Defense Department knows the attractiveness of going back to a single warhead approach and, therefore, is trotting out this argument as a reason for Congress not to preclude further testing. It may be true that a test of a given type of warhead can be developed that might be fractionally preferable, but there are many warheads that can be placed on almost any type of system today.

The interesting argument, and the only argument that has a degree of credibility that is worthy of consideration for all of us who might be in favor of a test ban, is that aspect of testing to find out how to make dirtier weapons cleaner. That has been particularly the history of the United States. So to prohibit testing does imply that we will cease experimentations on cleaning up some of the weapons.

Mr. SOLARZ. Will the gentleman yield?

Mr. LEACH. Of course.

Mr. SOLARZ. Are you saying that it is your understanding that it is possible for us to develop new nuclear weapon delivery systems without actually testing them with a nuclear warhead?

Mr. LEACH. Of course.

Mr. SOLARZ. So in your view we could develop the Midgetman without having to test the new warhead on the missile.

Mr. LEACH. Of course.

Mr. SOLARZ. And your position would be that we just take one of the existing warheads off the shelf.

Mr. LEACH. I am saying one could. It may not be the ideally suited weapon and it may be fractionally dirtier. The only negative to a test ban is that we do get away from some aspects of cleaning up some weapons.

Mr. SOLARZ. You are saying, then, that a total test ban treaty would not prohibit us from developing any new nuclear delivery systems that we want to test, and the same would be true with the Soviet Union?

Mr. LEACH. Any that I know that are on the horizon. You know, the whole history of weapons is that you take a very large system and make it smaller and smaller, and if one wanted to develop something with a multikiloton capacity the size of an elbow, there would be an advantage to further testing.

But the fact of the matter is that we haven't quite gotten to the *n*th degree in size reduction, although size reductions have been very important in terms of being able to have lowered the throw weights of the missile systems.

Mr. SOLARZ. If the gentleman will yield further, let me say the gentleman has made a very interesting point, but while I am profoundly opposed to the strategic defense initiative for all sorts of reasons, in the event that we proceed with it and some technology should emerge which can, in fact, insulate us from the consequences of a ballistic missile attack, we better have a prohibition on testing because otherwise over time they will miniaturize the nuclear weapons to the size of transistor radios and people will carry them into the country on commercial aircraft and we would be no better off than we were before.

You might be able to sell this to the administration as an adjunct to SDI as a way of preventing the Soviets from evading the beneficial consequences of a space-based mess.

Mr. Leach. I think you could sell it most as an antiterrorist system.

Mr. Berman. Just on that point, I am told that the U.S. warheads now are twice as good as the Soviet warheads in the relationship of yield to weight. Here is a case where perhaps, in addition to all its other benefits, the Comprehensive Test Ban Treaty can——

Mr. Leach. It is one of the few areas of nuclear weapons where we would freeze the Soviet Union in a disadvantageous position because we have done more sophisticated testing than they have.

Let me just conclude with the observation that last week someone called me in the middle of the night with an idea that defines the arms race as well as anything I have ever heard. Although I want to make it clear that I don't concur with it, what this person said is what we ought to do is forget delivery systems and just put 12 massive nuclear bombs around the United States, give the President a red button, and if he gets angry enough at the Soviets, tell him to press the button. We will all die instantly, but the Russians will take a week and it will be slow and torturous.

The point isn't that that is a good idea; but it certainly underlines that we are in this extraordinary world in which some of the sophist-type arguments about going to another *n*th degree ought to be reassessed from the point of view of basic sanity. Do we really need to?

As Congressman Bedell says, we would be putting a greater restraint on not only the other side but all other sides. I don't know of a single arms control initiative more important for the State of Israel, for instance, because, if there is one point in the world where a nuclear weapon is most likely to be used next, it is hard not to conclude that it might well be the Middle East.

Mr. Berman. Thank you very much, Berkley and Jim.

Congresswoman Boxer.

STATEMENT OF HON. BARBARA BOXER, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF CALIFORNIA

Mrs. Boxer. Thank you very much, Mr. Chairman.

I would like to ask retired Adm. Gene Carroll if he could come up here, because if there are any specific questions on verification, he would be able to handle some of those if I find myself wanting at that point.

Gene, come right here.

Mr. Chairman, I am going to be brief, because it has been a long hearing for you. First I want to compliment the committee for taking this up. As you know, I was one of the people who voted for a select committee on arms control. It is not a popular thing to say to you, but the reason was that I was concerned that this issue didn't get enough attention, and now I am very happy to see that it is getting your attention and some of the best minds of the committee have been with us today and I am very, very pleased about that.

You have many important obligations and duties in your committee, and I think this is certainly equal if not surpassing those others because this issue of nuclear arms control—and this isn't a partisan statement—is, obviously, the one that really concerns the life and death of the planet and the future, and I don't have to go into all the other reasons.

I want to commend my colleagues who were here previously, certainly Senator Kennedy and Senator Mathias and Berkley Bedell and Jim Leach, who remains with us, for introducing the Comprehensive Test Ban Treaty both in the Senate and in the House. As we know, it had great success in the Senate and now is the chance for the House to give it that equal success.

Mr. Chairman, the reason I didn't want to testify along with Berkley and Jim is that my bill is slightly different. Representative Nick Mavroules and I have introduced legislation now for the second time, last year we did it for the first time, which would constitute what I consider a first real action step toward achieving the goal of a test ban, really basically as a simultaneous step to the Kennedy-Mathias-Bedell-Leach legislation.

House Joint Resolution 119, what we have dubbed the nuclear test ban challenge, calls upon the President to halt the underground testing of nuclear weapons and challenges the Soviets to do the same.

This wasn't something that Nick Mavroules and I dreamed up. This is really a very successful precedent that was founded by President Kennedy in 1963. He announced at American University in that year that the United States would not conduct its next atmospheric test and he challenged the Soviets to do the same and that resulted in a rapidly negotiated treaty which has endured to this day.

Since 1963, Mr. Chairman, over 100 nations have joined the United States and the Soviets in signing this treaty. Unfortunately, underground tests continue and are a crucial part of the practice of developing new weapons.

I think it is important. I feel this way, and I do not know how many of you have seen the biography of John F. Kennedy, but it was very clear that this accomplishment of his, he considered to be the greatest achievement of his administration to the date that he served.

One of the main questions, and it is constantly being raised here at this panel, and indeed it should be raised, is in regard to the question of verification. If we stop underground testing, can we verify that the Soviets have also stopped testing? Could the Soviets conduct tests in secret and gain an advantage, and this is something that Congressman Solarz has suggested, over the United States in developing a new generation of nuclear weapons?

Verification is possible now; it wasn't in 1963, but it is now because of the scientific progress that we have made. I would like to put into the record two very important articles. One from "Scientific American," "The Verification of Compliance with Arms Control Agreements," and the other, by Jack Everndon, which Senator Kennedy referred to, called, "Politics, Technology and a Test Ban." Is it possible for me to put those in the record?

Mr. BERMAN. Yes; it is possible, and without objection, they will be included.[1]

Mrs. BOXER. Mr. Chairman, I want to quote just from two sentences from each of these articles. The Everndon article: "Seismologists have met all the technical problems of verifying a comprehensive test ban. Now it is clear that political considerations have stood in the way of such a treaty all along and verification problems have been used as an excuse." I think that is an important sentence.

From the other one in "Scientific American," by a number of scientists: "Military activities in the U.S.S.R. can be unilaterally monitored by the United States with the aid of a wide spectrum of remote sensing technologies including high resolution satellite photography." And again, these will go into great detail on the issue of verification.

Now, these articles conclude that even in the worst case scenario, one in which the Soviets attempted to evade detection of an explosion by muffling it in an underground cavity such as a salt mine, or by conducting it, and this would be tough, but we even look at that, conducting it to coincide with an earthquake, they are confident, these scientists, that we can detect such a blast down to 10 kilotons with instruments outside the Soviet Union, and one kiloton or less with stations inside the Soviet Union.

The Soviet Union, in negotiations with the United States and Great Britain during the Carter administration, and this has been brought out but I want to say it again for the record, agreed to a network of seismic monitoring stations within Soviet territory. Explosions of less than 1 kiloton would have very little, if any, military value when one considers that the bomb dropped on Hiroshima was 13 kilotons. That is why when Congressman Solarz debates this issue of 150 kilotons, you have to think that the damage done to Hiroshima was done with 13 kilotons. Most strategic weapons have reached yields in excess of 100 kilotons to the megaton range.

Scientists tell us that the only obstacles which remain are political, not technical. Mr. Chairman, the United States has nothing to lose and everything to gain by challenging the Soviet Union to end underground testing. The Soviets would have to answer to the Court of World Opinion if they refused to accept the challenge. They are very sensitive to their image, and have tried to portray the United States as the problem in arms control negotiations and themselves as being open to new agreements.

If we offer them this challenge, that is, if we stop testing and they do not, and we know we can verify it, we can seize the moral high ground. The Soviets would be in the difficult position of having to explain their refusal to cease testing to the world. I think they want to avoid that at all costs.

If the Soviets do not resume testing, what have we achieved? By this very act we have achieved a de facto test ban. That is what happened when President Kennedy issued that challenge in 1963: As long as they did not test, we did not test. This is the same thing. I think by moving on this legislation and the Bedell-Leach, et cetera, legislation, we open the first real window of opportunity for both countries to stop the race to produce new generations of weapons and begin talks to reduce the weapons we already have.

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[1] See appendixes 47 and 58.

Again, if the Soviets conduct tests in violation of this agreement, then the United States simply resumes testing, and we would be no worse off than we are today. I think that is the important.

The question is should we adopt this proposal now in light of the new arms control talks scheduled to begin in Geneva. I answer that with a resounding "yes" on a couple of levels. The administration has cautioned all of us not to set high expectations for these talks, and have stated it might take as long as 4 years to achieve any new agreements.

Mr. Chairman, from 1963 to 1983 the United States has conducted an average of 20 tests per year. I say we cannot wait 4 more years and allow at least 80 more underground tests all leading to new nuclear weapons systems. The administration failed to achieve any significant progress toward arms reduction during its first term. This administration did not even have negotiations going on for the vast majority of that time. Now they do. I say it is time for the Congress to take the lead, to join hands with the administration, not to impede them, but to help them.

I think House Joint Resolution 119 is a first step that does not cost us anything but holds the real potential of putting the brakes on an arms race that threatens to extend into space and leave a legacy of fear and uncertainty for our children and our world.

My daughter, and I know it is dangerous to quote children after Jimmy Carter did it a couple of years ago, but still and all, I am not a President; I am a mere Member of Congress. She is just 17 and said, she watched this program called "Threads," and it was about what happens after a nuclear explosion. She looked at me afterward and she said, "You know, Mom, people are going to commit suicide after watching this; this is the most depressing thing." We talked a long time because I was very concerned with that kind of talk coming from a teenager. The fact is, I said to her that if we watch these things and we do something to try and stop it, that in fact we are taking a positive step.

These children need this Congress to take a positive step now. We haven't done it. This committee is doing it today by listening and giving us a chance to have a word to talk about the most important issue that faces humankind. I would hope very much that as you listen, very carefully, because this is a very complicated subject, to the experts on verification, that you really listen well and hard and long, and that you come to the conclusion that I have come to: That we have moved ahead in technology in these last 20-odd years, and we do have the ability to verify an agreement like this, and that as we ask the President to negotiate this comprehensive test ban, he can take this first dramatic step just as John Kennedy did those many years ago, a step that has worked well. I say we can do it, and I say we will be applauded for doing it. Thank you.

[Congresswoman Boxer's prepared statement follows:]

Prepared Statement of Hon. Barbara Boxer, a Representative in Congress From the State of California

Mr. Chairman: I would like to thank the committee for providing me with this opportunity to testify before you today.

I commend my colleagues, Senators Kennedy and Mathias for their successful effort in gaining Senate support for a resolution calling on the President to begin to negotiate a CTBT. I also wish to commend my colleagues Berkley Bedell and Jim Leach for introducing campanion legislation in the House.

Mr. Chairman, Representative Mavroules and I have introduced legislation which would constitute the first real step toward achieving the goal of an end to the testing of any nuclear weapons and could hopefully be the beginning of the end of this arms race which no one can win. Our legislation is a logical simultaneous step to the Kennedy/Mathias, Bedell/Leach legislation.

House Joint Resolution 119, the Nuclear Test Ban Challenge calls, upon the President to halt the underground testing of nuclear weapons and challenges the Soviets to do the same. The process has a successful precedent in that President Kennedy employed a similar approach in 1963 when he announced at American University that the United States would not conduct its next atmospheric test and challenged the Soviets to do the same resulting in a rapidly negotiated treaty which has endured to this day.

Since 1963, over 100 nations have joined the United States and the Soviets in signing this treaty. Unfortunately, underground tests continue and are a crucial part of the process of developing new weapons.

One of the main questions raised in regard to this proposal is the question of verification. If we stop underground testing, can we verify that the Soviets have also stopped testing? Could the Soviets conduct tests in secret and gain an advantage over the U.S. in developing a new generation of nuclear weapons?

Verification is possible becuase of the scientific progress that we have made since 1963. Current issues of Scientific American and The Bulletin of Atomic Scientists, contain articles by eminant scientists which conclude that even in a worst case scenario, one in which the Soviets attempted to evade detection of an explosion by muffling it in an underground cavity such as a salt mine or by conducting it to coincide with an earthquake, they are confident we could detect such a blast down to 10 Kilotons with instruments outside the Soviet Union and 1 Kiloton or less with stations inside the Soviet Union. The Soviet Union, in negotiations with the U.S. and Great Britain during the Carter Administration, agreed to a network of seismic monitoring stations within Soviet territory. Explosions at less than 1 Kiloton would have little if any military value when one considers that the bomb dropped on Hiroshima was 13 Kilotons and most modern strategic weapons have reached yields in excess of 100 Kilotons to the megaton range. Scientists tell us that the only obstacles which remain are political, not technical.

Mr. Chairman, the U.S. has nothing to lose and everything to gain by challenging the Soviets to end underground testing. The Soviets would have to answer to the court of world opinion if they refuse to accept the challenge. They are very sensitive to their image and have tried to portray the U.S. as the problem in arms-control negotiations and themselves as being open to new agreements. If we stop testing and they do not, we seize the moral highground, and the Soviets would be in the difficult position of having to explain their intransigence and refusal to cease testing. This is a position they try to avoid at all costs.

If the Soviets do not resume testing then we have achieved a de facto test ban. As long as they do not test, we will not test. We open the first real window of opportunity for both countries to stop the race to produce new generations of weapons and begin talks to reduce the weapons we already have. If the Soviets conduct tests in violation of this agreement, then the United States simply resumes testing and would be no worse off than we are today.

Should we adopt this proposal now in light of the new arms control talks scheduled to begin soon in Geneva? Yes! the Administration has cautioned all of us not to set high expectations for these talks and have stated it might take as long as 4 years to achieve any new agreements.

Mr. Chairman, from 1963–1983 the United States has conducted an average of 20 tests per year. We cannot wait 4 more years and allow at least 80 more underground tests all leading to new nuclear weapon systems. This administration failed to achieve any significant progress towards arms reduction during its first term. This Administration did not even have negotiations going on for the vast majority of that time. It is time now for the Congress to take the lead, not in any way to impede progress but to help.

H.J. Res. 119 is a first step that does not cost us anything but holds the real potential of putting the brakes on an arms race that threatens to extend into space and leave a legacy of fear and uncertainty for our childran and our world. I urge the Committee to support the Bedell/Leach, Kennedy/Mathias proposal and also H.J. Res. 119 which would be a first positive and significant action towards a comprehensive test ban. The world will applaud us all as it applauded President Kennedy's achievement in 1963.

Mr. BERMAN. Thank you very much, Congresswoman Boxer, for your excellent and moving testimony. I myself remember the unilateral initiative by President Kennedy which led to the Limited Test Ban Treaty.

Is it fair to say that the logic of your proposal turns on the issue of verifiability, or do you believe that even if we didn't test for a while and they started testing, nothing that much would change in any event?

Mrs. BOXER. First, let me back up to your point about unilateral, because Congressman Mavroules and I definitely do not feel this is unilateral. It is a first step that we take, but in essence it must be mutual, because basically, if it is not complied with, we begin all over again.

Mr. BERMAN. But that gets back to the question of whether the issue turns on verifiability? Obviously this is in the absence of the seismic stations. Do present technical means exist to verify any underground test?

Mrs. BOXER. We believe that in order to detect the smallest test you need those onsite stations. So at the very first what we would hope would be achieved, and this is the way we see the scenario, that should the Congress pass this resolution and the Senate, and should the President determine in his own mind that it is in the best interests of America, because that is what he has to decide, in the interest of world peace, to go forward. That immediately upon stating that, that the Soviets could come to the table right away to negotiate because it would be a very dramatic step; it would be a real breakthrough.

What we envision in the best of all worlds is that immediately on announcing that within 6 months or 3 months, and he would have to deal with the date, that we would be willing to stop if they would stop. At that point, the thrust of this legislation is that they would come to the table, they would sit down, and we would set up the verification measures to do it.

Now should they not do that, we know that we can detect tests of up to 10 kilotons right now without being on site. So we could monitor that. The President might decide that he would stop all testing of 10 kilotons or less because we know in fact that we could verify that.

Mr. BERMAN. Ten kilotons or more?

Mrs. BOXER. That is right; 10 kilotons or more. But our hope is that on the announcement of this that they would immediately come to the table; that they would immediately start the negotiations. In fact, begin what Berkley Bedell and Jim Leach and Senators Kennedy and Mathias have talked about; the real hard-nosed neogtiations to allow those seismic stations within the Soviet Union. If not, we are willing to admit that it is the 10-kiloton range that we can detect anything over that.

Mr. BERMAN. Thank you.

Mr. Dornan.

Mr. DORNAN. Thank you.

I would like to ask my colleague a couple of questions since she refers a lot to President Kennedy. During the brief 2 years and 10 months he was the President, nothing brought him more pain than deception and lying by the Soviet Union, starting with Mr. Gromyko, the very gentleman that we still deal with now and going right on down the line to Ambassador Dobrynin. I would like to insert two short quotes from a speech that Kennedy made on March 2, 1962, and then ask you a question.

President Kennedy said in about the fifth paragraph of this radio-television address on March 2, 1962:

> On September first of last year,

Meaning 1961,

> While the United States and the United Kingdom were negotiating in good faith at Geneva, the Soviet Union callously broke its moratorium with a two-month series of more than 40 nuclear tests. Preparation for these tests had been secretly underway for many months, accompanied by new threats and new tactics of terror, these tests, conducted mostly in the atmosphere, represented a major Soviet effort to put nuclear weapons back into the arms race.

Then later in the same speech he said:

> We now know enough about broken negotiations, secret preparations and the advantages gained from a long test series never to offer again an uninspected moratorium.

In all of his biographies they say that the off-the-record comments went something to the effect of,

> I will never, ever again trust these SOB's; they have lied to me for the last time.

Given that and the breakthroughs that we have had in national technical means in verification, do you think that if the Soviets were to agree to onsite inspection, all of this would move forward so quickly as to make our heads spin? That if we could get that breakthrough, in regard to onsite inspection, that the United States would move quickly; that it would be a bipartisan, fast effort?

Ms. BOXER. Onsite inspection is very key to this whole issue. I think the good news is that in 1976, and I think testimony here before you arrived was that in fact the Soviets had talked about onsite inspection and had to really agree to it at that particular point in time and we would hope that they would at this time.

It is nice to see you; I haven't seen you since we debated the MX missile way back when. Everybody seems to take President Kennedy and quote him for whatever end point they want to make, and that is fine. I have no problem with that because you know what? The fact is these issues aren't black and white, and the fact is that we have to be cautious and we have to be careful and we have to be smart. I think that both the legislation that the Senators, which was bipartisan effort, have put into the hopper and is put into the hopper here, that is smart legislation. I think that the legislation that Congressman Mavroules and I have put in is smart legislation, because it doesn't say we are going to do something and just hope and pray that the Soviets follow through. We have learned hard, we know that that is not something that we can do.

I really have to tell you, since we are talking about testing, that since 1963, when that challenge was thrown out, there hasn't been an atmospheric test by the Soviet Union or by the United States. In the whole, long list of disappointments that we have had, that hasn't been a disappointment. I think now, at the stage we are at with verification, we can expand that to a comprehensive test ban, being very careful, being very sure and very cautious, I think it can work.

Mr. DORNAN. I just have one final question. In the Member's perception, why do you think the Soviet Union has come to a point where they are willing to start discussing something that was absolutely a matter that they wouldn't even approach. President Eisenhower, I remember, in his last, great foreign policy effort in the chambers of the League of Nations buildings in Geneva, actually ran down the hall to make one last effort before the Soviet delegation left to approach them again with an idea of, if not onsite inspection, totally open skies. That failure, of course, led to the U-2 flights over the Soviet Union.

Why do you think they have come to this point now where you think they are willing to sit down and come to some sort of a comprehensive ban? Do you think they feel there is no longer any high technology advantages for them to gain ground while we are adhering to any kind of a treaty, and they are using treaties as a guise as a drive toward more and more military superiority? What has changed in their national psyche at the Politburo?

Mrs. BOXER. I have got to tell you that I am not an expert in the Soviet Union, in their thinking, and I don't think I have to be. I think what I have to do as a Member of this Congress is try to find ways that bring an end to what I consider an insane arms race. I think I have that responsibility. All I care about right now is that when we put forward a proposal that I think will lead to a more peaceful world, that we are careful, that we are sure, the fact that they come to the table, they have been at the table years before.

I guess looking in your mind, and if I may be so bold as to try and do that, maybe your answer is because we have increased military spending 100 percent in 4 years. I don't happen to think that is the reason, because I happen to think that this arms race is akin to two people standing in a puddle of gasoline; one has got 10 matches and one has got 9 matches. I think that any superpower or any power in the world that doesn't understand that it is enough, and enough is enough is enough, doesn't have much intelligence. I have to think that just that very simple fact is enough to bring them to the table, but they have been at the table before.

As I said, in 1976 they agreed, preliminarily, to onsite inspection. I think they think as we do: Nobody wants to be blown up. There are mothers in the Soviet Union and dads and grandfathers and grandmas and I really think that they are concerned about the future. I think they are scared of us and I think we are scared of them. I think there never has been a better time to say that in the best interests of humankind and of our own country, now that we have this technological breakthrough that I alluded to in both of these articles, that we can move this test ban and make it comprehensive.

Mr. DORNAN. Suppose that their thinking is that we have awakened what Admiral Yamamoto referred to as the "Sleeping Giant," that we have awakened, that we are rebuilding, there are no more advantages to be gained, they have achieved parity with us or superiority, enough to make it debatable, and that therefore these weapons are relegated to nonuse as were poison gas weapons on the open battlefields. Suppose they said if we get this stalemate now, this gives us a conventional 4-to-1 lead, and we are not going to follow the bishops' pastoral letter and rebuild our conventional systems times four, let's face it. They say now we have this tremendous lead in biochemical warfare. If I were to believe completely what you said about their sensitivity to their image in the Court of World Opinion, why would a nation sensitive to its image murder 269 people on a jumbo jet? Why would they be genociding the Afghan people with poison gas? Why would they be filling every embassy around the world with spies?

They are not sensitive to their image; they know that their image is one of raw power, and that the world is sensitive to their power. They are not sensitive to anything. I think it is nice to think that the Politburo, whatever the leadership is now, as Mr. Chernenko fades from the scene and in less than 2 years we will have witnessed three leaders of the Politburo, I think that it is not common sense, but that it is, since you looked inside my mind, you guessed correctly, that it is a realization that the sleeping giant has awakened, and we are rebuilding our military structure and then they will decide that if they can get a stalemate in this area, that leaves them free to operate in foreign policy, as they will, because of their overwhelming conventional superiority and biochemical warfare superiority.

Mrs. BOXER. I feel I must make one 20-second response.

Mr. BERMAN. OK, but just to remind everyone, and Bob, because he came back from California late, he doesn't know, Ambassador Stoessel has been waiting, I guess now for 2 hours.

Mrs. BOXER. How about a 20-second response because I waited an hour and a half.

My response is I would prefer to listen to the Joint Chiefs of Staff than the Soviet Politburo; I honestly don't listen to them that much. I would prefer to listen to our own Joint Chiefs of Staff who have basically said that this country is strong, that they wouldn't trade positions with the Soviet Union, and therefore to indicate to me that we are negotiating from weakness, I just don't go along with it at all. I think that this test ban would be a tremendous benefit to our country and to the world.

Mr. DORNAN. Have you ever asked them that question privately?

Mr. BERMAN. That wasn't in the 20 seconds.

Mrs. BOXER. You want to get me an appointment with them?

Mr. DORNAN. The Joint Chiefs say that is an immoral question for any Congressperson to ask them publicly because they cannot answer it any other way than they do, because it would demoralize our troops and embolden the enemy. It is an idotic question that Congressmen and Senators keep asking the Joint Chiefs or any commander: Do you want to trade our guys for theirs. They are never going to answer it any other way but not "no," but "Hell, no." It is an immoral question to ask them.

Mr. Berman. Thank you.

Mr. Solarz.

Mr. Solarz. Is it possible for a non-Californian to get into this colloquy over here? I now understand, Mr. Chairman, why everybody is moving to California; it is not just the weather.

Let me say first of all that I want to pay tribute to the gentlewoman for some of the most impressive and impassioned testimony I have heard in my years on this committee. You obviously feel very strongly about this and I think you made a lot of very telling points. I think you are to be commended for taking the time to share your thoughts and all of the work you have evidently put in with this.

Let me ask you a few questions, if I might. It seems to me that in a certain sense one of the keys to your proposal is the idea that a comprehensive test ban can be verified. I suppose part of the problem here is that while you are able to produce experts who say it is verifiable, the critics or the administration will produce experts who will say it is not verifiable. I suppose the truth of the matter is that neither you nor I really have the technical expertise to decide whose experts are correct.

Listening to you testify, however, I had a thought, which I would like to try out on you. Part of the problem is that when you bring in an expert, people are suspicious of where the experts are coming from and if the President and the Joint Chiefs produce an expert, people are suspicious of where they are coming from.

Supposing we ask the Office of Technology Assessment, which has been established as kind of the scientific arm of the Congress, to do for us on scientific issues what the GAO does on other issues, to make a judgment about whether in fact this is verifiable and to assess the conflicting scientific evidence on both sides. It would seem to me that if they substantiated your conclusion that that would lend it great credibility.

Mrs. Boxer. I think it would be very good, a very good move.

Mr. Solarz. I am glad to hear you say that. I think what we need in the battle of the scientists is to come up with scientists who clearly have no ax to grind one way or the other.

I gather your resolution calls upon the President to, in effect, halt all further testing and to challenge the Soviet Union to do the same, correct?

Mrs. Boxer. That is correct.

Mr. Solarz. That implies that the President is willing to stop further testing?

Mrs. Boxer. That is correct.

Mr. Solarz. It also implies that the Soviet Union would be willing to stop further testing or, if they weren't, that we would soon find out in which case we would resume testing as well?

Mrs. Boxer. Yes.

Mr. Solarz. But the Soviets have presumably said they are in favor of a prohibition on testing, correct?

Mrs. Boxer. Well, we have reports of that, but again, we don't want to take them at face value.

Mr. Solarz. But you are reasonably hopeful that if we did this then they would follow suit?

Mrs. BOXER. I would hope so. Just as they did in the atmospheric test ban.

Mr. SOLARZ. Right. But if they didn't, then it would be of limited value. Then we would have scored perhaps some propaganda points; we really wouldn't have gained anything?

Mrs. BOXER. Right.

Mr. SOLARZ. It strikes me that what this really comes down to in terms of your approach is that it is dependent, first, on the willingness of the President to propose it, to take this intiative, and then it is dependent on the willingness of the Soviet Union to reciprocate. If both are willing, why not negotiate it?

Mrs. BOXER. The point is that is the Comprehensive Test Ban Treaty. It calls on the President to negotiate. But yet and still the President has to make that decision. We feel, Nick Mavroules and I, as we looked over the situation, feel that this particular legislation of ours, which is a slight twist on that, just says in a very dramatic way that we will not only sit down at the table, Congressman Solarz, but we will announce that we will take that first step. We think it is an exciting new approach.

Mr. SOLARZ. If I may say so, I think there is a logical flaw in your approach. Let me point it out and suggest an alternative you might want to consider.

The logical flaw is this: You, in effect, call upon the President to take this intiative, but the President, presumably, doesn't want to take the initiative. If the President doesn't take the initiative, then nothing happens. So you are calling on him to do something which he doesn't want to do. If he did want to do it, presumably your resolution wouldn't be necessary, because then he could sit down with the Soviets and rapidly conclude the negotiation. The problem is to find a way to get the President to do it. With all due respect, I rather doubt that the adoption of this resolution is going induce the President to do that which he does not want to do.

So it seems to me that if you really believe that such an initiative on the part of the United States would be in our interests, because it would either lead to a reciprocal gesture by the Soviet Union, which we would be in a position to verify, or, if it didn't, would leave us no worse off then we are now, why not consider the possibility of an amendment to the DOD bill which would prohibit us from conducting any tests unless and until the President reported to the Congress that we had evidence that the Soviet Union had engaged in a test? That way the Congress, over the opposition of the President, takes the very initiative you think the Nation should take.

The only reason I suggest this approach as an alternative to yours is that in fact if the President wanted to do what you are calling upon him to do, he would have done it. He doesn't need your resolution to do it. Whereas, if he doesn't want to do it, your resolution is not going to get him to do it. If we legislatively prohibit testing, then in effect we have done what you are calling upon the President to do, even though he is an unwilling participant in it, because presumably he is sworn to uphold the law of the land. If you are right in saying that we have the capacity to verify a Soviet violation, then we are protected if they should not reciprocate with a comparable gesture.

I am curious as to what you think of this alternative approach.

Mrs. Boxer. I would like to respond to that. I am a person who very much believes that when you are seeking peace that the executive branch and the legislative branch should walk down that road together. Therefore, I feel that you make every effort to bring about that type of joint walk. In my mind, if Congress were to indeed pass this resolution, and also the comprehensive test ban resolution, which as you know isn't law, but it is a sense of Congress, and we do presumably speak for the people who got us elected, and if at that point the President refused to carry it out, I would definitely consider the step that you suggest.

What I am saying is at this point I don't even know if the Congress in fact would like to see us go in this direction. I think it is a more orderly type of approach to try and persuade the President.

Mr. Solarz. I will tell you what my problem is: If we can persuade the President that a comprehensive test ban is in our interest, then I think it is preferable to have it negotiated.

Mrs. Boxer. Yes.

Mr. Solarz. I think having the United States take the kind of initiative you advocate only makes sense if the Executive is not willing to negotiate an agreement. Because if the Executive is willing to negotiate an agreement, it is far better in terms of the whole arms control enterprise to have it negotiated. There are always advantages to a negotiated agreement. There are nuances; there are provisions. We could, presumably, get agreements providing for onsite inspection in the context of a negotiated comprehensive test ban that would be very useful for future arms control agreements in terms of the precedents they would establish. Even if it meant waiting another couple of months, it would be well worth waiting a few more months to have the advantage of a negotiated agreement.

This kind of initiative really only makes sense if the person responsible for the negotiation doesn't want to negotiate. You can't compel the President to negotiate if he doesn't want to. If the President really doesn't want to, then I think the only other alternative that makes sense is the one that I outlined. You make a good point in that it is obviously better for the Executive and the legislature to march down this road together, and if what you are trying to do is to turn the President around, why not do it with a resolution which calls upon him to negotiate a comprehensive test ban.

Then if he says, the Congress has its opinion; I have my opinion; I am not going to pay any attention, then move to the other thing. But I don't see the sense, honestly, of calling upon him to take this initiative as distinguished from trying to negotiate it.

Mrs. Boxer. I think it is a very reasonable criticism and it is one that I will consider as we go through this. It is a very constructive criticism.

Mr. Solarz. You have obviously thought about this much more than I have.

Mrs. Boxer. It is only a year and a half. It doesn't mean your ideas are not good; they are good.

Mr. Solarz. Thank you very much.

Mr. Berman. Thank you very much, Congresswoman Boxer. It is always a pleasure to chair the hearing when you are testifying.

Ambassador Stoessel, I guess the moral of the story is don't agree to testify on a day when legislators are testifying to legislators. We appreciate your patience very much. For those who don't know, of course, Ambassador Walter Stoessel has been the U.S. Chief Negotiator to the talks on both the Threshold Test Ban Treaty and the Peaceful Nuclear Explosions Treaty during the Nixon and Ford administrations, and has also served as Ambassador to Poland, West Germany, and the Soviet Union. If my recollection of reading the Washington Post is correct, Ambassador Stoessel's spouse has also been very active in furthering U.S. diplomacy in her years of working with you.

STATEMENT OF HON. WALTER J. STOESSEL, JR., FORMER CHIEF U.S. NEGOTIATOR TO THRESHOLD TEST BAN TREATY TALKS AND PEACEFUL NUCLEAR EXPLOSIONS TREATY TALKS

Mr. Stoessel. Thank you very much, Mr. Chairman. Thanks for that reference to my wife, too. I was quite proud of her letter. I do appreciate your patience and that of your colleagues in waiting to hear my testimony. As you have already indicated in some of your remarks, my views are not entirely in accord with the views of the previous witnesses, but I do very much appreciate the opportunity to present them to you and your colleagues today.

In the interest of time, I will try and summarize parts of my prepared testimony which, certainly the initial part, is really historical as to how it came about that there was a negotiation for a threshold test ban treaty and how I was designated chairman of the delegation as Ambassador in Moscow.

That treaty prohibiting tests which would have a yield over 150 kilotons seems to represent quite a step forward in the provisions and the protocol for the exchange of data about the geology of the test areas of each country. This was the first time that such an agreement had been reached. As I say, it seemed to be a step forward.

That treaty provided for the negotiation of a subsequent Treaty on Peaceful Nuclear Negotiations to cover that aspect of the nuclear testing picture since it is impossible to differentiate between a test for peaceful purposes and a weapons test. So it was felt that that had to be covered as well.

The negotiations for the peaceful nuclear explosion agreement began in the fall of 1974. They went on for some 18 months, and were very detailed and, certainly in my recollection, very arduous. Attention was focused on the details of the verification procedure, and it was provided that, for group explosions of nuclear devices intended for peaceful purposes, there would be provision for onsite inspection. There would be arrangements made for observers to come to the test site with equipment including cameras, their own communication equipment and so on to observe and verify the test, the yield of the test and so on.

This too, seemed to be a real breakthrough in our efforts to improve the verification procedure. It was really not expected that there would be very many group explosions of the type mentioned in the treaty. The United States did not have its own active peaceful nuclear explosion program, and the Soviets seemed to be limiting theirs to single explosions. In any case, the provisions for this onsite inspection which were very detailed, seemed to be a step forward.

We did feel at the time that the agreements which had been negotiated and the procedures for verification, exchange of information and so on were adequate to permit verification of the limits called for in the agreements. As a negotiator, I felt that they were pretty good treaties at the time.

However, since those treaties were negotiated, and it is over 10 years now since the Threshold Test Ban Treaty was negotiated, there have been developments which I think place these conclusions about the adequacy of the provisions for verification in doubt. There is continuing controversy regarding our ability to verify with sufficient accuracy the yields of nuclear explosions in the Soviet Union.

Mr. Berman. Could you repeat that, please?

Mr. Stoessel. I said there is continuing controversy regarding our ability to verify with sufficient adequacy explosions taking place in the Soviet Union. I think the discussions we have had this afternoon indicated that. As Senator Kennedy said, one of the laboratories, Livermore, feels that we do have sufficient ability to verify; Los Alamos feels we do not. Some of the articles quoted by Congresswoman Boxer were to the effect that we can verify down to 1 kiloton, and there are many other scientists who would say, no, that is not true.

It seems that even though techniques and technology have progressed, such progress has perhaps added to the complexity of this problem. There is this continuing controversy. Also there is a record of Soviet violations of the Threshold Test Ban Treaty and of other arms control agreements. The President said in his latest report to the Congress in February that Soviet activities for a number of nuclear tests constitute a likely violation of obligations under the test ban treaty.

So given the persistent controversy over verification techologies and the record of Soviet noncompliance, including noncompliance with provisions of the Threshold Test Ban Treaty, my own conclusion is that it would be desirable to provide for enhanced verification procedures in the Threshold Test Ban Treaty and the Peaceful Nuclear Explosions Treaty before they are ratified by the U.S. Senate.

Now the President suggested in his speech to the U.N. General Assembly last September that such enhancement could be in the form of onsite observation of nuclear explosions. It is already provided for in the PNE Treaty in the case of group explosions, and the procedures which were worked out for those circumstances could be utilized for individual peaceful nuclear explosions as well as for nuclear weapon testing under the Threshold Test Ban Treaty.

The observers operating under these procedures would have very specifically formulated tasks to perform. They would not, as General Secretary Chernenko asserted last October, merely dispassionately ascertain the fact of the explosion. They would be able to determine yield and other characteristics of the explosions.

Now, I understand that the U.S. administration has made proposals to the Soviet Union in this sense; the Soviets have not yet responded officially; I believe the administration should continue its efforts in this regard, since I do feel that ratification of the two treaties, and particularly the Threshold Test Ban Treaty, would be a positive and practical step forward in our endeavor to limit nuclear testing.

If ratification could be accomplished, the experience gained in the implementation of the agreed verification procedures under the TTBT and the PNE treaties could be useful in moving forward a comprehensive test ban. I do feel for the present, however, that the uncertainties about the verification techology and the Soviet record of violations make it unwise for us to proceed to bilateral or resume trilateral negotiations for a comprehensive test ban treaty with the Soviet Union.

I think we should focus in the near term on ways to improve verification. Also, work in this regard could be done in the Committee on Disarmament, which operates in Geneva. There is a working group on verification procedures which has not been active for the last year. It would be desirable for that group, in a multilateral form, to continue its work on verification.

I feel that a comprehensive test ban should remain a goal, but that in the period before that can be achieved, weapons testing should continue within the limits set in the TTBT.

I do feel that testing will be necessary to ensure the credibility of our nuclear deterrent, to assure the viability of the weapons which are already in the stockpile as well as conducting tests for a new and smaller warhead to be associated with the single warhead, mobile, intercontinental ballistic missile called the Midgetman. The latter weapon is intended as a contribution to the stability of the strategic equation and it is possible that other weapons testing directed at the same objective may be required.

We can hope that negotiations with the Soviets can result in a radical reduction of offensive nuclear weapons, and if current research in both the United States and the Soviet Union can in time make effective nonnuclear defensive forces practical, then one can envisage an environment in which a complete cessation of nuclear testing would be entirely rational. Such a step would fit in with the ultimate objective of the elimination of both offensive and defensive nuclear arsenals.

Developments of this kind take time to mature. In the interim, and assuming a functioning threshold test ban regime, it might be possible to envisage a further limitation of nuclear testing through establishing quotas for the number of tests to be conducted by both sides. Such a system would operate to preserve the credibility of the deterrent and would at the same time be another move in the direction of a cessation of testing.

Mr. Chairman, I thank you and your colleagues for your patience.

[Mr. Stoessel's prepared statement follows:]

PREPARED STATEMENT OF HON. WALTER J. STOESSEL, JR., FORMER CHIEF U.S. NEGOTIATOR TO THRESHOLD TEST BAN TREATY TALKS AND PEACEFUL NUCLEAR EXPLOSIONS TREATY TALKS

Mr. Chairman:

I am most grateful for your invitation to appear today before the Subcommittee on Arms Control, International Security and Science. The subject of the hearings, "Proposals to Ban Nuclear Testing," is indeed topical, and one in which I have long been interested.

My direct experience with regard to efforts to limit nuclear testing occurred during my assignment as U.S. Ambassador to Moscow, 1974-1976, when the Threshold Test Ban Treaty (TTBT) and the Treaty on Underground Nuclear Explosions for Peaceful Purposes (PNE) were negotiated.

In anticipation of the summit meeting in Moscow in July, 1974, between President Nixon and General Secretary Brezhnev, both sides agreed to pursue the possibilities of further restrictions on nuclear testing going beyond the provisions of the Limited Test Ban Treaty signed in 1963 prohibiting nuclear-weapon testing in the atmosphere, in outer space and under water. A team of U.S. experts -- made up of representatives of interested government agencies as well as the Los Alamos and Livermore Laboratories -- was sent to Moscow in late May, 1974, to begin technical talks, and I was designated chairman of the delegation.

After negotiating intensively for one month, we reached agreement on the TTBT prohibiting tests having a yield exceeding 150 kilotons. The agreement, including its protocol, was signed by President Nixon and General Secretary Brezhnev July 3, 1974.

In our negotiations, the primary subject of our discussions was the protocol which specifies in detail the data to be exchanged between the U. S. and the Soviet Union on the geology of the test areas of each country to assist verification. While there was no provision for on-site inspection, and the information to be provided was to come from each side's sources, the provisions for exchange appeared to represent an important step forward in direct cooperation by the two major nuclear powers. For the first time, each party was to make available to the other data relating to its nuclear-weapons test program and its test sites.

Article III of the TTBT provided that an agreement on underground nuclear explosions for peaceful purposes would be negotiated at the earliest possible time. These negotiations began in Moscow October 7, 1974, and continued for over one and a half years. Once again, I was designated as chairman of the large U. S. delegation which attended the six negotiating sessions, all of them held in Moscow.

The PNE negotiations were extremely complex and arduous. Much of the attention of the negotiators was focussed on working out detailed provisions for on-site inspection, the first time that the two major nuclear powers had given such serious consideration to the subject. In the end, the two nations agreed, in a treaty signed May 28, 1976, not to carry out any individual nuclear explosions for peaceful purposes having a yield over 150 kilotons; not to carry out any group explosion having an aggregate yield exceeding 1, 500 kilotons; and not to carry out any group explosion having an aggregate yield exceeding 150 kilotons unless the individual explosions in the group could be identified and measured by agreed verification procedures.

These procedures for verifying group explosions constitute probably the most interesting part of the PNE treaty. As spelled out in the protocol, observers from the side not carrying out the explosion would be permitted access to the explosion site, and detailed provisions were made for the activities of such observers, including, inter alia, use of equipment, travel routes, photography, communications, privileges and immunities, housing facilities and payment of expenses. While it was not expected that group explosions of the type requiring on-site observers would take place often, the detailed provisions in the protocol for such observations constituted a real breakthrough in the history of negotiations to limit nuclear testing.

At the time when the TTBT and PNE agreements were negotiated, it was felt that the procedures regarding exchange of information called for in the treaties would be adequate to provide verification that the limits called for in the agreements would be observed. In the years since the negotiations -- over 10 years in the case of the TTBT -- developments have taken place which place this conclusion in doubt.

On the technical side, there is continuing controversy regarding our ability to verify with sufficient accuracy the yields of nuclear explosions in the Soviet Union. While experts differ, many maintain that, without direct, on-site inspection, it is impossible to obtain adequate verification, and they hold that this would be the case even with the exchange of data provided for in the TTBT. They note, too, that these data are to be provided from each side's sources, and they claim that -- given the record of Soviet violations or likely violations of arms-control agreements -- this is reason to question the reliability of such data.

This subject -- Soviet violations -- has been treated at length in several reports by the President to the Congress. As indicated in the most recent report of February 1, 1985, Soviet activities for a number of nuclear tests constitute a likely violation of obligations under the TTBT.

Given the persisting controversy over verification technologies and the evidence of Soviet non-compliance with a number of arms-control agreements, including the TTBT, I conclude that it would be desirable to provide for enhanced verification procedures in the TTBT and PNE agreements before they are ratified by the U.S. Senate.

As the President suggested in his speech to the U.N. General Assembly last September, such enhancement could be in the form of provisions for on-site observation of nuclear explosions. This is already provided for in the PNE treaty in the case of group explosions, and the procedures worked out for such events could be utilized for individual PNE explosions as well as nuclear-weapon testing under the TTBT. Observers under these procedures would have specific and carefully defined tasks to perform; they would not, as General Secretary Chernenko asserted in a press interview last October, "merely dispassionately ascertain the fact of explosion."

It is my understanding that the U.S. Administration has made proposals to the USSR in this sense, but that to date the Soviets have not responded officially. I believe the Administration should continue its efforts in this regard, since I feel that ratification of the two treaties, and particularly the TTBT, would be a positive and practical step forward in the endeavour to limit nuclear testing.

If ratification could be accomplished, then experience gained in implementation of agreed verification procedures under the TTBT and PNE treaties could be most useful in proceeding toward a Comprehensive Test Ban (CTB). For the present, however, I feel that uncertainties concerning verification technology, plus the Soviet record of violations, make it inadvisable to proceed immediately to bilateral -- or resumed trilateral with the United Kingdom -- negotiations for a CTB with the Soviet Union.

For the near term, we should focus on ways to improve verification techniques. As indicated, if the TTBT and PNE treaties are ratified after improvement of their verification provisions, then experience gained through their operation would be most valuable. Also, further consideration in the Working Group on Verification in the Committee on Disarmament in Geneva could also be of importance.

Pending negotiation of a CTB, which should always remain as a goal, weapons testing would continue within the limits set in the TTBT, whether ratified or not. In current and foreseeable circumstances for the next decade, such testing will be necessary to ensure the credibility of our nuclear deterrent, both to assure the viability of weapons already in the stockpile as well as conducting tests for a new, smaller warhead associated with the single warhead, mobile Midgetman missile. The latter weapon is intended as a contribution to the stability of the strategic equation, and other weapons testing directed at the same objective may also be required.

If, as one can hope, negotiations with the Soviets can result in a radical reduction of offensive weapons, and if current research in both the U.S. and the Soviet Union can in time make effective non-nuclear defensive forces practical, then one can envisage an environment in which a complete cessation of nuclear-weapon testing would be entirely rational. Such a step, indeed, would fit in with the ultimate objective of the elimination of both offensive and defensive nuclear arsons.

Developments of this kind will take time to mature, of course. In the interim, and assuming a functioning TTBT regime, it might be possible to envisage a further limitation of nuclear testing through establishing quotas for the number of tests to be conducted by both sides. Such a system would operate to preserve the credibility of the deterrent, while at the same time contributing another move in the direction of a cessation of all testing.

Mr. Chairman, I thank you and the members of the Subcommittee for this opportunity to appear before you.

Mr. Berman. Thank you, Mr. Ambassador.

In a short time, you said a number of different things, and I am sure the Members here have some questions.

Mr. Solarz has to leave, and so I am going to ask that he be able to throw out the first few questions.

Mr. Solarz. Thank you very much, Mr. Chairman.

Mr. Ambassador, it is good to have you back and to get the benefit of your wisdom and experience. Just two brief questions: We heard some testimony and statements earlier today that it would in fact be possible to develop the Midgetman without explicitly testing a new Midgetman warhead, by presumably taking some existing warhead that we already have in production, and attaching that to the Minuteman delivery system.

You seem to feel otherwise. Could you let us know why that is not the case?

Mr. Stoessel. Well, Mr. Congressman, I think this is a question for the experts, really. I am under the impression that for optimal results, for the best type of missile and weapons system, that additional testing, development of a new warhead would be required, but I am far from an expert in this very arcane field.

Mr. Solarz. Secondly, based on your experience dealing with the Soviets and your participation in the arms control process, if we come to the conclusion the Soviets have in fact committed serious violations of existing arms control agreements, would it be your view that we should announce that we would no longer consider ourselves bound by the terms of those treaties which they violated, or would you go beyond that and say that we would no longer consider ourselves bound by any arms control treaties we have entered into with them, even including those with respect to which we have no evidence that they have violated.

As part of that, would you also refuse to enter into any new arms control agreements with them, assuming we have come to the conclusion that they have engaged in serious arms control violations of existing agreements?

Mr. Stoessel. In the situation you have described, and if the violation is truly serious, my inclination would be to restrict our action, our cancellation of the agreement to that particular agreement and not extend it to the whole range of agreements we have with the Soviet Union.

I would also not be deterred from attempting to negotiate further agreements with the Soviet Union, but one would always have in mind the violation which had occurred and would be doubly cautious, then, about the type of agreement to be made in the future.

Mr. Solarz. Thank you very much.

Mr. Chairman, I appreciate it. I am much in your debt.

Mr. Berman. Mr. Dornan, would you like to be much in my debt?

Mr. Dornan. Yes, please, thank you, Mr. Chairman.

Mr. Ambassador, I enjoyed our meeting when I first met you in Germany and you were on watch over there about 8 years ago, I guess, and I always enjoy so much your thoughtful approach to the issues.

One thing that I do not know if they touched on it before I came late to the hearings today, but it is the program that the Soviet

Union calls their peaceful nuclear program. They have indicated that under no circumstances at all, whatsoever, are they going to stop or even inhibit their peaceful program where they use nuclear power for blasting canals out; for massive construction sites—how are we ever going to differentiate between the testing of nuclear power for a so-called peaceful purpose or its application to a military purpose. Have you ever figured that one out?

Mr. STOESSEL. Well, of course, Mr. Congressman, that was the purpose of that agreement on peaceful nuclear explosions. There would be procedures to verify; there would be an exchange of data and they would have to tell us where they were going to explode, what the geology of the area was, and so on; and this would be tests or explosions for these purposes under 150 kilotons.

Mr. DORNAN. At the earliest stages of PNE, did they discuss onsite inspection? Not with black boxes, but literally with teams?

Mr. STOESSEL. Well, not right at the beginning, but we made clear that for this kind of explosion, and in order to verify it, we would have to have onsite inspection in certain cases; that is if there were a number of explosions which would go off in a relatively limited time span, and the aggregate could reach up to 1,500 kilotons, we would have to have inspectors, observers, on the ground to check the yield of each separate explosion.

Actually, as I indicated, they agreed to that, perhaps because they did not plan to have such group explosions. There had been earlier talk about the digging of canals and so on. They do not seem to have proceeded with that type of program, and while they are still active in using these explosions for peaceful purposes, they seem to be confined to single explosions for digging out excavations for oil storage or gas storage, sometimes for putting out fires in coal mines, things like that. They have done that, but they have not really proceeded with group explosions.

I think that for purposes of checking the group explosions, the onsite procedures which we negotiated were good and sufficient, and I would like to see those extended to single explosions, either peaceful or weapons testing. I think the precedent is there now and we should try and build on that.

Mr. DORNAN. I have just been given the assignment, the task, and I welcomed it to join seven other Republican colleagues and seven Democratic colleagues to go to Geneva in a couple of weeks to witness the whole process there, and I had had this honor years ago, during the SALT II negotiations.

In doing so, I asked if I could learn something about the Russian negotiating team, and I was given a book, highly sensitive as you know, with a very high classification; and I found it so fascinating, the accumulation of information and background on these people, which might lead to their thought processes or how they would operate independently or as part of a negotiating team, that common sense compelled me to ask if they had a book like this on our team, and the response was, "of course."

Given the fact that they analyze us in depth, at the time Koreagate had sort of faded and Abscam was not yet to come up on the radar scope, I said, would all that be in there? Oh, yes, every clipping on your public life or whatever else they could get is in that information booklet, as we try to do the same.

I think that there is a great deal of value in trying to analyze not only their specific negotiating team, but the people that are giving them orders.

Now Mrs. Boxer, in a very charming way, although I do not find much charm in the argument that I do not care what they do; it is what we do that is important—I do not care about the Politburo, how they think; I am not an expert on that. Do you think that the attempts by our intelligence community and our diplomatic community and the Senate and the House committees that have to address these serious issues, that these various groups should spend as much time as they possibly can assessing the motivations, looking at these things particularly through their viewpoint, what their geopolitical goals seem to be, what their past conduct is. Do you think these things should play an important role in how we approach any type of negotiating process?

Mr. Stoessel. Oh, I think so very definitely.

Mr. Dornan. I agree.

Mr. Stoessel. And I think a lot of work is done in this regard, as you know, by our various agencies. And in general terms, of course, we know quite a bit about overall motivations and history and actions and so on. When it comes down to individual personalities, there is a lack of information.

This is one of the problems we have in dealing with the Soviet Union and dealing with the Politburo. We do not know all that much about it.

Mr. Dornan. You have personally sat with Mr. Gromyko.

Mr. Stoessel. Right.

Mr. Dornan. Just by the sheer weight of years and the illness of the last three Soviet Politburo leaders, he has amassed a tremendous amount of power in the area of foreign affairs, it would seem.

Mr. Stoessel. Yes.

Mr. Dornan. So his past record and how he has participated or used the negotiating process, I think should be an important issue to all Members of the House and the Senate.

Mr. Stoessel. Very much so. I agree.

Mr. Dornan. Mr. Chairman, if I could ask you, please, could we leave this fascinating testimony today open at this point where I might put in the testimony of say Dr. Edward Teller and some others that also feel, without being dogmatic about it, that the verification process is a very complex thing and that there are thoughtful people on both sides of the issue who have not resolved the level of technical skill or technical means here.

Mr. Berman. I think it is probably a good idea to leave the record open since there is this scientific question of what can be verified and what can be to let information on both sides of that question come into the record and get a broader sense.[1]

Could I take a few more minutes of your time? I know it is getting late.

Mr. Stoessel. Sure.

Mr. Berman. This is new to me. This is the first subcommittee meeting since I got on the subcommittee I had totally forgotten about those two limited test ban treaties that have never been ratified until I started looking at the issues involved in this hearing. Your testimony interests me very much, but I am unclear about certain facets of it.

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[1] See appendix.

Are you saying that at this particular time, you now do not want to see ratification of the Threshold Test Ban Treaty and the Peaceful Nuclear Explosion Treaty until the verification procedures are strengthened; or are you saying you want to see them ratified and then we move toward trying to strengthen the verification procedures?

Mr. STOESSEL. No, I would like to see the verification procedures strengthened before ratification.

Mr. BERMAN. In the area of the Peaceful Nuclear Explosions Treaty, there is a principle of onsite inspection that is established for group explosions. But it also may be that the Soviets were quite willing to concede this tremendous new gain in verification procedures because they have no interest in having group explosions.

In the area of the singles explosions, they did agree to the principle of these seismic safety stations in the Soviet Union?

Mr. STOESSEL. No, that was not part of those agreements.

Mr. BERMAN. That new principle came in the discussions on the Comprehensive Test Ban Treaty?

Mr. STOESSEL. That is correct. I was not involved in those negotiations, and I understand there was discussion of seismic stations; however, there was not agreement on the details, how many there should be, and so on. It has been said that about 90 percent of the comprehensive test ban treaty was agreed, but the last 10 percent, as you know, is always the hardest. I think that is what they were up against: Very precise details of the verification system.

Mr. BERMAN. Would that notion, the notion of the nontamperable seismic safety device placed inside the Soviet Union assuage your concerns regarding the verification of the limits placed by both treaties that you were involved in negotiating?

Mr. STOESSEL. Well, it would help, certainly. I hesitate to answer positively since again it is a question for the experts. I think you would have to have sufficient agreement on the part of the experts that adding a system of black boxes would resolve the questions about verification. It is possible that it would.

The President has suggested, as I mentioned, in his U.N. speech, that there be onsite observers. I think that would be the best. Now failing that, one could consider a system of seismic stations. This certainly would be an additional enhancement of the verification procedures.

Mr. BERMAN. I am confused about what has happened since the mid-1970's when you negotiated those treaties I assume supported ratification at that time. What makes you feel now that we should delay ratification? Is it that the exchange of data provided for in those agreements turns out not to be all that you thought it was?

Mr. STOESSEL. Well, it is my understanding again that the experts at the time of negotiation felt the exchange of data would be adequate for verification. We had on our delegation as I recall, representatives from Los Alamos and Livermore, and we had several academic representatives and they were experts, and they thought this would be sufficient.

Since that time, in the intervening years, more questions have developed, and that is what concerns me. There is a controversy in the ranks of the experts. So I think also on the part of the administration, this is a problem. Something more seems to be needed before we could proceed with confidence to ratification.

Mr. BERMAN. So at this time the clear weight of scientific evidence, in your opinion, is not behind the notion that we can adequately verify through the means provided in those treaties whether or not 150 kiloton and over tests are being conducted underground in the Soviet Union?

Mr. STOESSEL. That is right, yes. There are some who say you can; some who say you cannot. The mention was made of a factor of two, and I think the factor has gone up since then, in the minds of various experts.

Mr. BERMAN. Two kilotons or two times?

Mr. STOESSEL. Well, that you could have an error and a 150 kt explosion could be 75 or it could be 300.

Mr. BERMAN. Oh, that is a fair margin.

Mr. STOESSEL. The range of its uncertainty is even greater, according to some of the experts.

Mr. BERMAN. In other words, some of the experts now think that an explosion of somewhere in the 350-kiloton range could be interpreted as under 150.

Mr. STOESSEL. Could be, or could be much larger.

Mr. BERMAN. I guess we start from what we think the explosion is, and what it could be, not from what the explosion is to what we think it could be.

I gather your testimony is that at this point, even for the two treaties already negotiated, the seismic stations placed in the Soviet Union would certainly help; but you at this point do not feel comfortable stating that they would resolve this issue of verification.

Mr. STOESSEL. That is correct.

Mr. BERMAN. They might but they might not; you are not sure.

Mr. STOESSEL. I am sure they would help, but whether they would help sufficiently, I do not know.

Mr. BERMAN. Who do you think we should talk to to find out?

Mr. STOESSEL. I suppose a range of experts. I would think talking with ACDA would be of use, and then perhaps some of the experts from the laboratories themselves; Los Alamos, Livermore.

Mr. BERMAN. By the way, does one find nonideological scientists in this? We do not with lawyers and politicians, but what about in the scientific area?

Mr. STOESSEL. Well, again, I do not know. They all have their views and perhaps those views fit into a certain ideological category. They might say that they are not ideological in their outlook; they are scientific.

Mr. DORNAN. They never show guilt until after they have discovered things. Then they sit back and think about it.

Mr. BERMAN. But going on further, then, even if the verification is totally satisfactory, you are personally against negotiating a comprehensive test ban treaty at this time because of its consequences on our military capability?

Mr. STOESSEL. Yes, that is true. I think we will have to continue testing, and we have to maintain the credibility of the deterrent, and for that some testing is necessary. There is also a question, too, of losing expertise in the laboratories. If you stop the testing, you lose the people who do these things, and that could be a disadvantage.

Mr. BERMAN. What about the point we were talking about earlier; that we do in some very crucial areas have key advantages over the Soviet Union and as Congressman Bedell so eloquently pointed out, that constraint is a constraint on the Soviet Union as well as on us. And that the logical extension of your position is that we can never negotiate a comprehensive test ban treaty because there is always some further aspect of testing of nuclear weapons that might refine and enhance our nuclear capability.

Mr. STOESSEL. As I indicated, I think that there could be an interim stop. You could have a system of quotas; specify a certain number of tests annually, which could be a further step toward controlling the number of these tests, and that is assuming adequate verification.

In the long run, as I indicate in my testimony, one can hope that a reduction of offensive nuclear arms can be achieved. This is the purpose of the Geneva talks. This can take a long time, but that is possible.

Mr. BERMAN. You think that is where our priorities should be in arms control.

Mr. STOESSEL. I think that is where the priorities should be now, and that in this period, hopefully, there will be a transition period toward a time when we have many fewer nuclear weapons, where some defenses along the lines of the strategic defense initiative of a nonnuclear kind can be obtained. At that time then one could contemplate a cessation of nuclear testing.

Mr. BERMAN. Of course, Brent Scowcroft says that to the extent we pursue that nonnuclear defensive system, it is going to be very tough to ever get the Soviets to willingly agree to a major reduction of offensive weapons.

Mr. STOESSEL. Well, now we get into another whole area of debate.

Mr. BERMAN. If there are no further questions, then I just want to thank you very much for your patience and sharing your insights with us.

Mr. DORNAN. One inquiry, Mr. Chairman, would you have any objection to my placing your testimony in the Congressional Record tomorrow, Mr. Ambassador?

Mr. STOESSEL. No, no, I would welcome that.

Mr. DORNAN. Thank you very much.

Mr. STOESSEL. Thank you, Mr. Chairman.

Mr. BERMAN. Thank you. The hearing is adjourned.

[Whereupon, at 5:50 p.m., the hearing was adjourned, to reconvene at 3:30 p.m. on Tuesday, April 30, 1985.]

PROPOSALS TO BAN NUCLEAR TESTING

TUESDAY, APRIL 30, 1985

House of Representatives,
Committee on Foreign Affairs,
Subcommittee on Arms Control,
International Security and Science,
Washington, DC.

The subcommittee met, at 3:30 p.m., in room 2255, Rayburn House Office Building, Hon. Dante B. Fascell (chairman of the subcommittee) presiding.

Chairman Fascell. We have a vote on now. We'll expect some other votes, and the ranking member had asked me to hold off markup on House Joint Resolution 3, which I am prepared to do for 1 week. So, the minority should get to us quickly the names of the witnesses they wish to have testify, because we are going to mark up this bill next week.

And, Mr. Emery, I am sorry. I appreciate your being here. We want your testimony, though.

Mr. Emery.[1] We could reschedule this, too.

Chairman Fascell. Yes; we will reschedule this for sometime next week. We will let you know——

Mr. Emery. That will be fine.

Chairman Fascell [continuing]. Tuesday, Wednesday, or Thursday, obviously, of next week sometime. And we would like to get you on the record with respect to these matters.

And we will go from there. And we also have the other bill, ACDA authorization bill.

So, OK, thank you very much. Sorry we have to do this.

[Whereupon, at 3:32 p.m., the subcommittee adjourned, to reconvene at 2:30 on Wednesday, May 8, 1985.]

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[1] David Emery, Deputy Director, Arms Control and Disarmanent Agency.

PROPOSALS TO BAN NUCLEAR TESTING

WEDNESDAY, MAY 8, 1985

House of Representatives,
Committee on Foreign Affairs,
Subcommittee on Arms Control,
International Security and Science,
Washington, DC.

The subcommittee met in open markup session, at 2:55 p.m., in room 2200, Rayburn House Office Building, Hon. Dante B. Fascell (chairman of the subcommittee) presiding.

Mr. Berman. Even though the chairman has not returned yet from the last vote, we are going to start this hearing.

We have with us today three witnesses, a representative from the Arms Control and Disarmament Agency, and that is presumably Dr. Barker, the Director; Dr. Donald Kerr, Director of the Los Alamos National Laboratories; Dr. Lynn Sykes, Higgins Professor of Geological Sciences; and Lamont-Doherty, Geological Observatory.

On the committee agenda sheet it is listed that a representative of the Arms Control and Disarmament Agency would proceed first, so, Dr. Barker, why do you not go ahead?

STATEMENT OF ROBERT BARKER, DEPUTY ASSISTANT DIRECTOR FOR VERIFICATION AND INTELLIGENCE, ARMS CONTROL AND DISARMAMENT AGENCY

Mr. Barker. Thank you.

Good afternoon. I am happy to be here today to comment on behalf of the administration on House Joint Resolution 3.

This resolution, as you are aware, in its current form, calls for the President, at the earliest possible date, to request advice and consent for the Senate to ratification of the threshold test ban and peaceful nuclear explosions treaties. The President is also invited to submit with these treaties a report on any plans he has to negotiate supplemental verification procedures or any understanding or reservation on the subject of verification that should be attached to the treaty.

Further, House Joint Resolution 3 calls for the President at the earliest possible date to propose to the Soviet Union the immediate resumption of negotiations toward conclusion of a verifiable, comprehensive test ban treaty.

This resolution is unacceptable to the administration. Careful study led us for 4 years to conclude that the threshold test ban treaty in its current form is not effectively verifiable. Ratification of this treaty before ratification improvements can be negotiated with the Soviets is not in the national security interest of the United States.

Similarly, thorough evaluation has led the administration to reaffirm that a comprehensive test ban remains a long-term objective of the United States; an objective which we will seek to pursue within the context of broad, deep, and verifiable arms reductions, the maintenance of a credible nuclear deterrent, expanded confidence-building measures, and improved verfication capabilities. There is much to be accomplished with respect to each of these objectives. It is not yet time to undertake negotiation of a comprehensive test ban.

Let there be no doubt about this adminstration's commitment to effective arms reduction agreements and to the objective of the total elimination of nuclear weapons. We seek to achieve these goals while striving to strengthen and maintain the security and stability which the entire world desires. In this context, we are convinced that deep reductions in the offensive nuclear weapons of the Soviet Union and the United States must have our highest priority.

The recent return by the Soviets to the negotiating table they walked away from in 1983 had given us the opportunity to resume our effort in this regard. In seeking deep reductions, we will demand equality and require effective verification in any resulting treaty. These criteria are critical for strategic stability. We and the whole world must be convinced that agreements negotiated are agreements to be complied with.

Unfortunately, the Soviet record on compliance, rather than giving increased confidence in arms control, gives rise to grave concerns. As the President has said:

> Soviet noncompliance is a serious matter. It calls into question important security benefits from arms control and could create new security risks. It undermines the confidence essential to an effective arms control process in the future.

The Threshold Test Ban Treaty offers an area where the Soviets can demonstrate that they take arms control seriously, that they too, recognize that the true benefits of arms control can only be achieved when all parties are secure and confident that the treaty terms are being complied with. The United States must stand by its standard of effective verification with respect to the Threshold Test Ban Treaty. Anything less would undermine our ability to demand effective verification in this and other treaty areas, as well as being a disservice to the objectives of the Threshold Test Ban Treaty itself.

There is almost universal acceptance in this country that true treaty verification cannot be based on trust. Yet the Threshold Test Ban Treaty, in the name of verification, offers only an exchange of data which, while appearing extensive, contains not a single meaningful element that can be independently validated by the United States. There is not ability for us to independently measure any of the important parameters upon which our estimates of Soviet yield are based.

Those who negotiated and signed the Threshold Test Ban Treaty, with today's hindsight, were optimistic. They believe that our understanding of the science of seismology was good enough for us to determine Soviet nuclear weapon test yields to an accuracy sufficient to protect U.S. security. They also expected that the Soviets would comply with the treaty.

Since 1976, when the Soviet Union claimed that it would abide by the provisions of the Threshold Test Ban Treaty, two things have happened to change that earlier perspective. First, we have had to recognize that we cannot determine Soviet nuclear yields with the accuracy required for effective verification. Second, we have had to conclude that it is likely that the Soviets have violated their legal obligations with respect to the Threshold Test Ban Treaty.

The Threshold Test Ban Treaty cannot now be effectively verified. The Soviets are likely in violations of their legal obligation to limit test yields to 150 kilotons and below. Verification must be improved before the President could in good faith determine that this treaty is in the national security interest of our Nation and before he could thus seek the advice and consent of the Senate to its ratification.

The administration has not been passive on this issue. In 1983 and again in 1984, we sought on a number of occasions to engage the U.S.S.R. in discussions on verification improvements for the Threshold Test Ban Treaty and the Peaceful Nuclear Explosions Treaty. In addition, in his address to the U.N. General Assembly on September 24, 1984, President Reagan proposed an exchange of visits to allow Soviet experts to come to the U.S. nuclear test site and U.S. experts to go to the Soviet nuclear test site to measure directly the yields of nuclear weapons tests.

We recognize that any improvements to verification of the Threshold Test Ban Treaty must be mutually arrived at between the United States and the Soviet Union. In other words, they must be negotiated. They cannot be dictated by the United States and imposed upon the Soviet Union. For this reason we have not approached the Soviets with a unilateral nonnegotiable demand. We have instead sought an honest exchange of technical views on how verification can be improved. Regrettably, the Soviets have thus far rejected all our proposals to meet and confer on verification improvements.

Today the Soviets may perceive a lack on unanimity, a lack of commitment, within the American Government on the issue of TTBT verification. They can have no doubt about the administration's position: Effective verification must precede ratification. But thus far the Soviets have not heard congressional endorsement and support for the administration position on the strengthening of verification measures. House Joint Resolution No. 3 does not now call upon the Soviets to join us in seeking verification improvements to the threshold test ban treaty.

Returning to the subject of the comprehensive test ban treaty, our problems with House Joint Resolution 3 are no less severe. We would all like to reduce and eventually eliminate our dependence upon nuclear arms. However, as the current discussion of the strategic defense initiative has highlighted, many Americans as well as American allies are seeking assurance that the U.S. nuclear deterrent will be effectively maintained until a better alternative is available. Today this requires nuclear testing.

As we modernize our nuclear deterrent to make it more survivable and better able to contribute to stability, we will require some new nuclear weapons to arm those new weapon systems. In the interest of stability we must also retain our confidence that our deterrent is reliable. And; while the safety and security record of our nuclear forces is unparalleled, as technologies become available which can make them even more safe and secure, who would bear the burden of not incorporating these improvements into our nuclear weapons? Weapon modernization, confidence in the deterrent, and enhanced nuclear weapon safety and security are today all dependent upon nuclear testing. It is important, therefore, to understand that our reliance on a credible nuclear deterrent has an essential bearing on the time frame within which consideration can realistically be given to negotiation of a comprehensive test ban treaty.

As with the case of the Threshold Test Ban Treaty, effective verification is also a necessary condition for a comprehensive test ban treaty. Today it does not exist. The United States has spent hundreds of millions of dollars on research to establish the basis for verifiable nuclear test limitations. This administration is continuing that search. As part of that effort we have actively supported multilateral involvement in nuclear test ban verification studies at the 40-nation conference on disarmament in Geneva.

In sum, the ingredients are not yet available for comprehensive test ban negotiations. Further, we must not allow a search for a comprehensive test ban to become once again a diversion and surrogate for negotiations of deep and meaningful arms reductions. The signatories of the nonproliferation treaty sought in article VI of that treaty the elimination of the discrimination that is manifest in the differentiation between nuclear weapon states and nonnuclear weapon states. Elimination of that distinction can only be achieved with the elimination of nuclear weapons. Radical reductions in the number of offensive nuclear weapons should be the first step in that direction.

Congressional support for U.S. efforts to achieve such reductions in the current Geneva negotiations have been substantial, and we believe such support is not lost on the Soviets. Clearly, when administration and Congress are seen working together, our chances for success with the Soviets are greatest.

It is therefore to be regretted that House Joint Resolution 3 is not supportive of these clearly and consistently stated administration objectives and priorities. Your support for our efforts to enhance verification would be most helpful and most welcome.

This completes my prepared remarks. I'd be happy to answer your questions.

Chairman Fascell. Thank you very much, Dr. Barker.

Next we are happy to hear from Dr. Donald Kerr, director of the Los Alamos National Laboratory.

Dr. Kerr please proceed.

STATEMENT OF DONALD KERR, DIRECTOR, LOS ALAMOS NATIONAL LABORATORY

Mr. KERR. Mr. Chairman, members of the committee it is a pleasure to have the opportunity to discuss the issues of arms control and test limitations with you. I hope that what I will say will assist in understanding this difficult and important subject.

Our laboratory, owned by the Department of Energy, has been run by the University of California since it began in 1943. The first nuclear and thermonuclear weapons were designed at Los Alamos, and today over two-thirds of the nuclear weapons currently in the U.S. stockpile were designed by our laboratory. We know the tremendous destructive power of these weapons, and we have long hoped that the world's leaders would find ways to reach effective arms control agreements.

We were also the pioneers of technical means of nuclear verification, including the ground-based VELA optical systems, followed later by the VELA satellites and their successors. I also, however, bear the responsibility of personally certifying that the weapons we design will work and that they have appropriate safety features. That responsibility weighs heavily.

For three decades, bans or limitations on testing of nuclear weapons have been one of the most frequently and widely supported forms of nuclear arms control. Yet testing restraints constitute a highly technical approach to arms control, and they have often been advocated as an alternative to political approaches and agreements when this avenue appeared to be closed by controversy or concern over military and strategic problems.

Testing restraints in the past have raised questions about the credibility of our own deterrent about possible United States-Soviet asymmetry. It is not certain that they can significantly advance the cause of nuclear arms control or be a substitute for direct reductions of nuclear weapons. As long as we rely on nuclear weapons, we must test them. Our Nuclear Weapon Test Program is essential in designing, engineering, manufacturing, maintaining, and certifying weapons. Certification, simply put, is a guarantee from the nuclear weapons design laboratories that weapons will perform to specifications throughout their stockpile life, in peacetime and in war. Equally important, this certification is a promise that they will be safe and resistant to unauthorized attempts to use them by terrorists or others.

Nuclear tests are essential for determining the proper functioning of a nuclear explosive. Calculations do not suffice, and there is no way experimentally to simulate the total performance of a nuclear weapon. Therefore, without testing, no new designs ought to be put into stockpile. In the same vein, testing is necessary for undertaking desired risk-free improvements. Nuclear testing allows us to make weapons safer, to improve controls to prevent or deny unauthorized use, to improve design efficiency, and to reduce costs and special nuclear material requirements, and lastly to design weapons to reduce collateral damage. And it contributes significantly to our ability to study weapons effects, the knowledge of which is essential for responding to the threat posed by Soviet offensive and defensive nuclear systems.

Nuclear testing is essential for maintenance of the stockpile. In the early 1960's for example, we discovered evidence of serious deterioration in a major strategic system. It required testing to demonstrate whether the system would function. Nuclear weapons are affected significantly by aging and obsolescene. Over an extended period, some of the materials used in warheads deteriorate physically. Maintenance of the stockpile depends on regularly scheduled random sampling in which nuclear weapons are disassembled and inspected. If irregularities are found, they are referred to the experts at the weapon design laboratories for their judgment as to the severity of the problem and the necessary correction.

This may be done on the basis of past tests, but an additional test may be required if the weapon is to be retained in the active inventory. In such cases, without the test or tests required, certification of the weapon would be impossible.

The fact that we rarely conduct proof tests, that is, specific individual tests of a weapon pulled from the stockpile, is sometimes cited as evidence that testing is not necessary to maintain confidence in the reliability of the stockpile. This is incorrect. We do not conduct occasional proof tests, but we also use the continuing testing program to confirm the design choices made in the stockpiled weapons.

Testing programs are essential in maintaining the nuclear weapons capability of the Nation. Without an Experimental Testing Program which challenges our nuclear weapon designers and tests their designs, we would lose our best designers, and those remaining would not be able to demonstrate the validity of their theories.

This was our experience under the testing moratorium from 1958 to 1961. Without an experimental testing program, we would expect the technical base of knowledge and experience required for developing and maintaining weapons to dissipate and disappear.

The Threshold Test Ban Treaty establishes a nuclear threshold by prohibiting tests with a yield exceeding 150 kilotons, a provision the United States observed scrupulously. Within this limit, the laboratory is able to maintain the present stockpile and our nuclear design capability. Without testing over 150 kilotons, we can, within limits, undertake modifications of nuclear weapons to enhance safety, improve efficiency, reduce cost, and achieve other desired improvements. The laboratory can design and certify new weapons with high confidence if they are 150 kilotons or below, or with reduced confidence if they are not larger than the threshold by about a factor of two. The laboratory will not be able to design and develop high-yield weapons based on designs that depart significantly from those of the past.

Under the threshold test ban, there is a serious potential for Soviet violations which could create asymmetries with military signficance. Even if the Soviet only conducted one or two high-yield tests every few year, it might be possible for them to develop new high-yield weapons.

The data exchange provisions of the Threshold Test Ban Treaty have not yet come into effect. Consequently, we do not know how valuable this geophysical data would be. But it is not obvious that the exchange of geophysical data upon ratification of the Threshold Test Ban Treaty will reduce ambiguities about Soviet tests and increase confidence in Soviet compliance with the treaty. For verification of the TTBT, we now depend upon remote teleseismic monitoring. This methodology includes random errors and systematic errors such as the seismic bias between the Nevada test site and the Shagan River test site. With remote teleseismic monitoring, we simply cannot know what the actual yields of underground tests are. We are forced to infer yields from the seismic signals resulting from a nuclear weapons test. We can only say with certain probability, but no certainty, that a given test did or did not exceed the 150-kiloton threshold.

It has on occasion been suggested that Los Alamos believes that the Soviets have violates the 150-kiloton limit, while our sister laboratory at Livermore disagrees. We have tried to analyze the saismic signals statistically, and we have concluded that the issue of Soviet compliance is unresolved and presently unresolvable given the nature of the data available to us. To resolve it, at Los Alamos and elsewhere, we are exploring improved and new verification methodologies. An intrusive onsite verification technique called CORRTEX, which is a hydrodynamic shock measurement, has been developed and used by Los Alamos for measurement of nuclear test yields; providing a direct and much more accurate estimate of yield than any remote technique, it now appears especially promising. It could provide much improved confidence in Soviet compliance with the Threshold Test Ban Treaty and help resolve some of the major uncertainities and ambiguities in remote monitoring data.

The United States continues to observe the threshold provisions, and we believe we can perform our current responsibilities under its limitation. But in order to reduce concern about potential military disadvantages to the United States, we would urge improved verification. We would then have greater confidence that the Soviets were subject to symmetrical restrictions.

The desirability of entering into negotiations on a comprehensive test ban is a political question. I will primarily speak to the technical question of the effect of the CTB on the national security mission of the laboratory and the Department of Energy nuclear weapons complex.

A CTB would lead to loss of confidence in the reliability of our nuclear weapons and would result in substantial erosion of our capability to design, manufacture, and maintain nuclear weapons. A CTB would effectively preclude responsible and desirable modernization of the nuclear stockpile and prevent desirable risk-free improvements to enhance the safety, efficiency, economy, and extended reliability of our nuclear weapons.

We cannot be certain that a CTB would equally constrain the Soviets. Since we do not know the specifics of Soviet nuclear weapon design, we are simply unable to say whether they would be affected by a CTB in the same manner and to the same extent that we are.

I cannot share the view of those who argue that an effective, verifiable CTB is within our grasp. Even with monitors on Soviet soil and onsite inspections, verification of a CTB would involve considerable uncertainties. Verification concerns with a CTB involve a different range of yields than with a threshold test ban. In essence, the problem of verifying a CTB is detection of relatively small seismic events and the unequivocal identification of their source.

All experts agree that there is some lower limit below which nuclear tests in hard rock cannot be detected with remote seismic monitors. But it is possible to disguise tests of relatively large nuclear weapons by exploding a device inside a hollow underground cavity, for example. Most of the energy is not coupled into the earth and does not produce ground motion. Hiding tests in earthquakes or using shock-mitigating materials may confuse the issue of decoupling even further. A militarily significant nuclear test program could in this way be unrecognized by a remote teleseismic monitoring network.

The limitations of current nuclear testing verification technologies are not viewed, however, with resignation. We are working to discover new and improved techniques. A verification method that senses ionospheric disturbances produced by nuclear explosions is being developed by Los Alamos and appears promising, and high-frequency seismic measurements may hold promise for increasing sensitivity to decoupled tests, although this means to be demonstrated.

Against these costs and risks of the CTB, its proponents offer two asserted benefits, which are primarily political in nature. It is frequently claimed that a CTB will break the arms control logjam—that a carefully negotiated, binding, and fully verifiable CTB could be the breakthrough that would result in genuine arms control through reductions in nuclear arsenals. However, many of the same political and military concerns that have prevented significant nuclear arms reductions also stand in the way of agreeing to a CTB. To focus on a comprehensive test ban as the goal of arms control policy seems to me to work the wrong side of the problem.

It is also questionable whether a CTB would significantly improve the nonproliferation regime, as proponents claim. From a technical point of view, a comprehensive test ban has only a marginal effect on the proliferation of nuclear weapons. Testing is not essential for designing and building the simple, first-generation fission devices that a would-be proliferator is likely to want at the beginning of a nuclear weapons program. Politically, a CTB is unlikely to have a significant long-term effect on the problem of proliferation and the strength of the nonproliferation regime. It is unliekly that the states interested in building nuclear weapons are driven primarily by the bad example of the major powers, and a CTB is not likely to prevent a country from deciding to develop nuclear weapons if it believes it can and should do so. Nor would it be likely to meet the goals of the nonnuclear weapon states by bringing about general and complete disarmament or ending the distinction between nuclear and nonnuclear weapon states.

The real unknown technical costs of the CTB, then, appear more compelling than anticipated political benefits. It is certain, however, that we must continue to test if we intend as a nation to rely upon nuclear forces in our defense posture, as we expect to do for the foreseeable future.

As a weapons laboratory director, I have the responsibility for overseeing the development of the nuclear weapons on which the United States relies for deterrence and defense. While I believe that the current national security role assigned Los Alamos National Laboratory could be performed under a threshold test ban treaty, conditions do not exist now that would allow me to give unqualified support for a comprehensive test ban. I understand, perhaps as well as anyone, the awesome and dreadful power of nuclear weapons, and I believe that priority should be given to efforts to control deployed warheads capable of inflicting harm. I share the hope that such talks will be successful.

Mr. Chairman, I paraphrased my prepared statement, and I would appreciate permission to provide that to you for the record.

Chairman FASCELL. Your entire statement will be included in the record.

Thank you very much, Dr. Kerr.

[Mr. Kerr's prepared statement follows:]

Prepared Statement of Donald M. Kerr, Director, Los Alamos National Laboratory, University of California

Mr. Chairman, Members of the Committee, it is a pleasure to have the opportunity to discuss the issues of arms control and test limitations with you; I hope that what I say will be helpful in understanding this difficult and important subject. Our Laboratory has been operated by the University of California since 1943, originally as part of the Manhatten Project and now for the Department of Energy. The first nuclear and thermonuclear weapons were designed at our Laboratory, and over two-thirds of the nuclear weapons currently in the US stockpile are Los Alamos designs. We know the tremendous destructive power of these weapons, and we have long hoped that the world's leaders would find ways to reach effective arms control agreements. We were also the pioneers of technical means of nuclear verification, including the ground-based Vela optical systems followed by the Vela satellites. I also, however, bear the responsibility of personally certifying that the weapons we design will work and that they have appropriate safety features. That responsibility weighs heavily.

For three decades, bans or limitations on testing of nuclear weapons have been one of the most frequently suggested and widely supported forms of nuclear arms control. Yet, testing restraints constitute a highly technical approach to arms control. And they have often been advocated as an alternative to political approaches and agreements when this avenue appeared to be closed by political controversy or concern over military-strategic problems.

At this moment of considerable concern about the future of arms control, many voices from within the United States and outside are encouraging the US Government to move ahead on restraining nuclear weapons testing--by ratifying the Threshold Test Ban Treaty (TTBT) and the Peaceful Nuclear Explosives Treaty (PNET), by reopening negotiations on a Comprehensive Test Ban (CTB), and perhaps even by moving boldly in advance of nuclear arms control negotiations with a unilateral moratorium on US nuclear weapon tests. H.J. Res. 3, which urges the President to submit the TTBT and PNET to the Senate for its advice and consent to ratification, and to propose to the Soviet Union the immediate resumption of negotiations on a CTB, appears to indicate congressional support for this approach. We currently believe our national security can be protected under the TTBT, particularly if its provisions for verification were improved. However, other approaches to nuclear test bans and testing moratoria could have an adverse effect on US national security, and it is not certain that they can significantly advance the cause of nuclear arms control or be a substitute for direct reductions of nuclear weapons.

EXPERIENCE WITH TESTING LIMITATIONS

Our experience with testing restraints in the past has been mixed. From October 1958 to September 1961, the Soviet Union, the United Kingdom, and the United States observed a moratorium on nuclear testing agreed to on a voluntary basis (i.e., without a written agreement). This was the first major post-war agreement between the United States and the Soviet Union directly affecting nuclear armaments. The moratorium was entered into after the nations involved had reached an impasse on negotiations for a CTB, and involved no agreed-upon verification measures.

In December 1959, President Eisenhower indicated that the United States would no longer be bound by the moratorium, although it would give advanced notice if it intended to resume testing. Then, on September 1, 1961, the Soviet Union, without previous warning, resumed nuclear tests in the atmosphere, including high-altitude, rocket-launched tests. They immediately carried out a series of around 40 tests, and within two years they had undertaken over 100 tests. This number of nuclear tests could only have been possible after lengthy, secret preparations. The United States quickly responded with an underground weapons test series, and began preparations for atmospheric tests. Upon ordering the resumption of testing, which revealed a number of stockpile problems directly attributable to the moratorium on testing, President Kennedy declared: "We know enough about broken negotiations, secret preparations and the advantages gained from a long test series never again offer an uninspected moratorium."

A new approach to negotiated restraints on nuclear testing was taken, and in 1963 the Limited Test Ban Treaty (LTBT) was signed, banning nuclear weapon tests in the atmosphere, underwater, and in outer space. The United States hoped that the LTBT would lead to a general improvement in relations between the United States and the Soviet Union, and to other, more significant restraints on nuclear weapons. While the more ambitious consequences of the LTBT have not yet been realized, it did provide protection to populations from the effects of radioactive fallout from nuclear tests. The signatory nations have complied with the prohibition on atmospheric and underwater nuclear weapon testing since the treaty was signed (although France and the People's Republic of China, which are not signatories, continued testing above ground). But LTBT prohibitions on the release of radioactivity across national boundaries as a result of testing has become a bone of contention between the United States and the Soviet Union, as venting of radioactive material from Soviet tests has been detected on numerous occasions.

In the 1970s, the Threshold Test Ban and the Peaceful Nuclear Explosives Treaties were negotiated. The PNET included an extensive protocol on verification methods to assure compliance, negotiated with scientific input from both sides. Since the treaty remains unratified, this protocol has not entered into force. However, compliance with the PNET has not been questioned. On the other hand, Soviet compliance with the 150 kiloton (kt) limit on underground nuclear weapon tests specified in the TTBT has been hotly debated within the United States for some time. The United States has depended upon seismic measurements from remote stations to monitor Soviet compliance with the 150 kt limit. These measurements are sometimes ambiguous and have led to uncertainty and controversy over Soviet behavior under the TTBT.

It is not clear that our previous experiences with restraints on nuclear testing have been productive, if one of their goals was to build confidence between participants which might provide the basis for further agreements. If we do contemplate new restraints on nuclear weapons testing that are not to jeopardize our security, they must be developed within the total context of our national security policy and negotiated with full input from both the policy and technical communities. They must be verifiable, and should include appropriate sanctions for detected non-compliance.

REASONS FOR NUCLEAR TESTING

As long as we rely on nuclear weapons, we must test them. Our nuclear weapon test program is essential in designing, engineering, manufacturing, maintaining, and certifying weapons.

Certification

Certification is a guarantee from the nuclear weapons design laboratories that weapons will perform to specifications throughout their stockpile life, in peacetime as well as in war. Equally important, it is a promise that they will be safe and resistant to unauthorized attempts to use them by terrorists or others.

Nuclear Research and Development

Nuclear tests are essential for determining the proper functioning of nuclear explosives. Calculations do not suffice, and there is no way experimentally to simulate the total performance of a nuclear weapon. Without testing, no new designs ought to be put into stockpile. In some cases, however, existing designs can be adapted for use in other delivery systems. We are concerned that, given real life pressures and fallible human nature, we might occasionally stockpile new designs or inadequately reasoned changes in old ones. Serious unreliability could result.

Of course, preventing the development of new generations of nuclear weapons--which are generally viewed as inherently more dangerous, destructive and destabilizing--is precisely what the proponents of testing limits have as their objective. However, testing has been and continues to be necessary for reducing the dangers and destructiveness of nuclear weapons. Indeed, testing is necessary for advancing our knowledge in desirable areas, without at the same time taking unreasonable risks. Nuclear testing allows us to make nuclear weapons safer, and to improve controls to prevent or deny unauthorized use. It allows us to improve design efficiency and to reduce the cost and special nuclear material requirements of warheads, as well to design weapons to reduce collateral damage. And nuclear effects tests, primarily carried out by the Defense Nuclear Agency, contribute significantly to our ability to study the effects of nuclear weapons on our weapons systems, as well as on our command, communications, reconnaissance and other assets. This knowledge is essential for responding to the threat posed by Soviet offensive and defensive nuclear systems by, among other means, hardening our command, control, communications and intelligence (C^3I) capabilities. We increasingly rely on such capabilities to avoid war, to manage crises, to maintain the credibility of our deterrent and, in the event of war, to assure our defense.

Maintenance of the Stockpile

Nuclear testing is essential for the maintenance of the stockpile. In the early 1960s, for example, we discovered evidence of serious deterioration in a major strategic system. Testing was required to demonstrate whether the system would function. In essence, nuclear weapons are affected significantly by aging and obsolescence. And, over an extended period, the materials used in warheads deteriorate physically. Expected stockpile lifetimes for warheads are typically between 15 and 25 years, but some designs have required corrective measures much sooner. In the past, new weapons usually replaced those in the stockpile before the older weapons deteriorated. But without nuclear testing, the possible effects of physical deterioration would become increasingly important.

Maintenance of the nuclear stockpile depends on regularly scheduled random sampling, in which nuclear weapons are disassembled and inspected. Irregularities that are found--as they are, from time to time--are referred to the experts at the weapons design laboratories for their judgment as to the severity of the problem and the necessary "fix." The solution is often one that can be validated on the basis of previous research and development tests related to the system in question, or to related systems. These fixes can be made without a new nuclear test. In cases where such validation is not possible, we occasionally decide that an additional test is required if the weapon is to be retained in the active inventory. In all such cases, without the test or tests required, certification of the weapon, at least as we have known it until now, would be impossible.

Under a comprehensive test ban, given real life pressures and human fallibility, we might on occasion make inadvisable changes or stockpile inadequately tested designs. During the testing moratorium, the US introduced the W52 Sergeant warhead into the stockpile. After Soviet testing brought an end to the moratorium, resumed US testing revealed the warhead was inoperative. Further testing was required to make the necessary corrections. Moreover, we had the experience during the moratorium of making safety-related changes in a stockpile weapon, with full confidence in those changes. When testing was resumed, and the weapon tested, it failed.

Human judgment is critical to our confidence in nuclear weapons. Without testing, the anticipated decline of confidence could result in a decline in our willingness to rely on the nuclear stockpile for deterrence. It could also lead to an increase in numbers of weapons to make up for declining confidence, or the development of even more lethal, non-nuclear weapons.

A frequently held notion should be specifically dispelled. The fact that we rarely conduct "proof" tests--that is, specific individual tests of a weapon pulled from the stockpile--is sometimes cited as evidence that testing is not necessary to maintain confidence in the reliability of the stockpile. This is incorrect. Sometimes we do conduct classical proof tests, pulling a weapon directly from the stockpile. In addition, we use the continuing testing program to confirm the design choices made in stockpile weapons, and we reuse the tested technology of weapons in the stockpile in designing new weapon systems. If we encounter a stockpile problem, we may proof test its solution by adding an experiment to a test that is part of the continuing program. In effect, continuous proof testing is the basis of our entire testing program.

Maintenance of Nuclear Design Capability

Not only is nuclear testing essential to the maintenance of the nuclear stockpile, but the US nuclear weapons laboratories have maintained for years that testing programs are essential in maintaining the nuclear weapons capability of the nation. Without an experimental testing program, which challenges our nuclear weapon designers and tests their designs, we would lose our best designers. Those remaining would not be able to demonstrate the validity of their theories. This was our experience during the test moratorium. In effect, over a period of years, we would expect the technical base of knowledge and experience required for developing and maintaining weapons to dissipate and disappear.

RATIFICATION OF TTBT

The TTBT, signed in 1974, establishes a nuclear "threshold" by prohibiting tests with a yield exceeding 150 kt. The US, as I have indicated, observes the 150 kt threshold scrupulously. Within this limit, the Laboratory is able to maintain the present stockpile and our nuclear design capability. Without testing over 150 kt, we can within limits undertake risk-free modifications of nuclear weapons to enhance safety, improve efficiency (yield-to-weight ratio), reduce cost, tailor effects to reduce collateral damage, and achieve other design improvements. As well, needed nuclear effects testing can be undertaken. The Laboratory can design, produce and certify new weapons with high confidence if they are 150 kt or less, or with lessening confidence if they are not larger than the threshold by approximately a factor of two (2) and if the design has been tested in the past at higher yields. The Laboratory will not be able to design and develop high-yield weapons based on designs that depart significantly from those of the past. Unless the US established new, high-yield weapons requirements, we can live with such restrictions on our own program. However, we are concerned about what the Soviets can do under the TTBT.

Soviet Compliance

Under the TTBT, there is a serious potential for Soviet violations. Without knowledge of the procedures employed by the Soviets to develop and certify their weapons, and with the intrinsic uncertainties of the methodology we use to verify Soviet compliance with the Treaty, we believe that they could test at levels that might allow them to execute proof tests of the weapons believed to comprise the bulk of their stockpile or test new designs with even higher yields. Even if they conducted one or two high-yield tests every few years, it might be possible for them to develop totally new high-yield weapons. Thus, potential Soviet noncompliance with the provisions of the Treaty could create a serious asymmetry with military significance.

Verification of a TTBT

In the Protocol to the TTBT, the US and the USSR agreed:

> For the Purpose of ensuring verification of compliance with the obligations of the Parties under the Treaty by national technical means, the Parties shall, on the basis of reciprocity, exchange the following data:
>
> a. The geographic coordinates of the boundaries of each test site and of the boundaries of the geophysically distinct testing areas therein.
>
> b. Information on the geology of the testing areas of the sites (the rock characteristics of geological formations and the basic physical properties of the rock, i.e., density, seismic velocity, water saturation, porosity and the depth of water table).
>
> c. The geographic coordinates of underground nuclear weapon tests, after they have been conducted.
>
> d. Yield, date, time, depth and coordinates for two nuclear weapon tests for calibration purposes from each

> geophysically distinct testing area where underground nuclear weapon tests have been and are to be conducted. In this connection the yield of such explosions for calibration purposes should be as near as possible to the limit defined in Article I of the Treaty and not less than one-tenth of that limit. In the case of testing areas where data are not available on two tests for calibration purposes, the data pertaining to one such test shall be exchanged, if available, and the data pertaining to the second test shall be exchanged as soon as possible after the second test having a yield in the above-mentioned range. The provisions of this Protocol shall not require the Parties to conduct tests solely for calibration purposes.

The parties agreed that these data (a, b, d) would be exchanged simultaneously with the exchange of instruments of ratification, and the data exchange provisions of the TTBT have not yet come into effect. Consequently, we do not know how valuable this geophysical data would be. But it is by no means certain, as some would have us believe, that the exchange of these data upon ratification of the TTBT will reduce ambiguities about the size and site of Soviet tests, or that it will increase confidence in Soviet compliance with the provision of the TTBT. If we were certain the data exchange would effectively result in effective verification, it would indeed be ironic and, I believe, insupportable to hold up ratification of the TTBT on the grounds of inadequate provisions for verification. However, any possible reduction of uncertainty that might result from data exchanges and calibration shots specified in the Protocol to the TTBT would depend, in part, on our confidence in the accuracy of the data provided by the Soviets and the value of the technical data themselves. The Treaty does not provide for confirmation of the data supplied. We would have to trust the Soviets on this vital matter to a far greater degree than we have in other areas.

It is not now obvious, moreover, how these Soviet data could serve significantly to reduce yield measurement uncertainties. For verification of the TTBT, we now depend upon remote teleseismic monitoring. This methodology includes random errors, as well systematic errors such as the seismic "bias" between the Nevada Test Site (NTS) and the Shagan River test site. In light of these limitations, we simply cannot know what are the actual yields of underground tests. We are forced to infer yields from the seismic signals resulting from a nuclear weapons test, and there is uncertainty in our inferences. We can only say with a certain probability--but no certainty--that a given test did or did not exceed the 150 kt threshold. More specifically, from each seismic measurement of a test, we can infer a central yield. But because of inaccuracies in our measurement techniques, we can only say that the actual yield was probably within a fairly broad range above or below the inferred central yield. The higher the central yield above 150 kt, the lower the probability that the test was actually in compliance with the TTBT's threshold. But to have extreme confidence that a given test exceeded the threshold, the central yield must be very high indeed.

It has on occasion been suggested in public that Los Alamos believes that the Soviets have violated the 150 kt limit, while Livermore disagrees. Los Alamos has analyzed the compliance issue statistically, using models believed to be consistent with official positions and actions. We concluded that the issue of Soviet compliance is unresolved and, with the methods of verification that are presently available, unresolvable. In essence, the problem involves uncertainties in measurement (encompassing both the nature of statistical measurement and the amount and accuracy of available data) and the difficulties of translating these uncertainties into high-confidence conclusions about compliance. To resolve this problem, at Los Alamos and elsewhere there are explorations of improved and new verification methodologies that have the potential for increasing confidence in our ability to determine Soviet compliance with the TTBT.

Remote teleseismic devices and analysis methods have been extensively investigated. These are now being extended to consider high-frequency portions of seismic signals which have not yet been examined, and which may offer greater possibilities for accurate monitoring of tests. Other new techniques are being investigated, including measurements of sound waves and ionospheric disturbances caused by nuclear explosions underground. A technique called CORRTEX (a hydrodynamic shock measurement) has been developed and used by Los Alamos National Laboratory for on-site measurement of nuclear test yields. Providing a direct and much more accurate estimate of yield than any remote technique, it appears especially promising. If application of this technique were allowed, it could provide much improved confidence that other states were abiding by the terms of a threshold test ban. In addition, this method could help resolve.some of the major uncertainties and ambiguities in remote monitoring data, by providing a continuous flow of calibration measurements on nuclear test events. This technique could be used to respond to President Reagan's call, in his September 1984 speech to the General Assembly of the United Nations, for direct on-site but non-intrusive verification of compliance with the TTBT.

The United States continues to observe the TTBT but, in order to reduce concern about potential military disadvantages to the United States, we would urge improved verifiability. We would then have greater confidence that the Soviets were subject to symmetrical restrictions. Ultimately, of course, ratification of the TTBT is a political decision, in which adequacy of verification is a crucial but not the only consideration. Proponents of ratification have often argued on purely political grounds, however, occasionally asserting that ratification would be a symbol of serious US commitment to arms control, and would improve the prospects for a CTB or other arms control agreements. I am skeptical of such reasoning, and I am concerned that it could unduly influence the ratification debate to the point of eclipsing verification issues.

To assess verification issues, several policy questions must be first answered. We must determine at what yield level the enforcement of Soviet compliance is considered necessary; what frequency of incorrect technical reporting of violations can be tolerated (the acceptable false-alarm rate); and what priority should be attached to avoiding false allegations of noncompliance, on one hand, and to preventing occasional violations of potentially military significance, on the other. From a technical standpoint, initial Los Alamos analyses have indicated that of all improvements studied, only hydrodynamic yield measurements could significantly reduce the uncertainties regarding Soviet underground test yields.

CTB NEGOTIATIONS

The desirability of entering into negotiations on a CTB is a political question. I will primarily speak to the technical question of the effect of a CTB on the national security mission of the Laboratory and the DOE nuclear weapons complex. A CTB would lead to a loss of confidence in the reliability of our nuclear weapons and would result in substantial erosion of our capability to design, manufacture and maintain nuclear weapons. A CTB would effectively preclude responsible and desirable modernization of the nuclear stockpile, and prevent desirable risk-free improvements to enhance the safety, efficiency, economy and extended reliability of our nuclear weapons. As long as we depend upon nuclear weapons for deterrence and, ultimately, defense, these consequences are highly undesirable.

Would A CTB Equally Constrain the Soviets?

We cannot be certain that a CTB would equally constrain the Soviets. Since we do not know the specifics of Soviet nuclear weapon design, we are simply unable to say whether they would be affected by a CTB in the same manner and to the same extent that we are. It is by no means certain that a CTB would prevent the Soviets from developing a new generation of nuclear weapons, although that would assuredly be the effect of a total testing ban on the United States. More important, it has been recognized, even by proponents of a CTB, that in the long-term some degree of testing would be necessary to assure the credibility of the deterrent. This is true, and it is quite possible that the Soviet military nuclear technology base and most of their nuclear stockpile could be preserved and maintained indefinitely with tests of a few tens of kilotons in violation of a total testing ban.

Verification

Equally important, or perhaps more important in this context, are verification uncertainties. I cannot share the view of those who agree that an effective, verifiable CTB is within our grasp. Even with monitors on Soviet soil and on-site inspections, verification of a CTB would involve considerable uncertainties. Verification concerns with a CTB involve a different range of yields than with a TTBT. In essence, the problem of verifying a CTB is detection of relatively small seismic events and the unequivocal identification of their source. As seismic magnitude decreases, the number of naturally occurring events during any period increase dramatically. Given this fundamental fact, under a CTB even greater verification difficulties would beset us than under a TTBT, especially if we were largely dependent upon remote teleseismic monitoring.

All experts agree that there is some lower limit below which nuclear tests in hard rock cannot be detected with remote seismic monitors; the usual figures cited are one, two, or at most a few kilotons. Proponents of a CTB argue that this is sufficient to assure compliance. But it is possible to disguise tests of relatively large nuclear weapons to make them appear (to remote monitors) relatively small or as something other than a nuclear test. By exploding a device inside a hollow underground cavity, for example, most of the energy from the explosion is not "coupled" into the earth and does not initiate seismic signals. Hiding explosions in earthquakes, or using shock-mitigating materials, may confuse the issue of decoupling even further. A militarily significant nuclear test program conducted in this way could be unrecognized by a network of remote teleseismic monitoring stations. Further, a CTB could require a much more extensive monitoring network than now exists, because we would have to protect against the possibility of a violator conducting tests clandestinely underwater, in the atmosphere, and in outer space, as well as underground.

Indicating that current nuclear testing verification technologies have significant limitations does not mean that nuclear testing restraints will remain unverifiable forever. On the contrary, it suggests that serious work needs to be devoted to new and improved technologies. At the moment, two directions for verification R&D are clearly indicated: augmenting remote monitors with on-site techniques, which I believe are necessary but not sufficient, and improving remote monitoring techniques themselves. Work is proceeding in both directions at the US nuclear weapons laboratories and other places. As I indicated, a promising verification method that senses the ionospheric disturbances produced by nuclear explosions is being developed by Los Alamos. And, high-frequency seismic may hold promise for increasing sensitivity to decoupled tests, although this remains to be demonstrated.

A CTB, Arms Control, and Non-proliferation

Against these costs of a CTB, its proponents offer two asserted benefits, which are primarily political in nature. First, it is frequently suggested or asserted that a CTB will break the arms control logjam, that a carefully negotiated, binding, and fully verifiable CTB could be the breakthrough that would result in genuine arms control through reductions in nuclear arsenals. However, even the staunchest proponents of a comprehensive test ban have recognized that a CTB will not by itself end the arms race; and will not result in a reduction of nuclear weapons, and their decommissioning and dismantlement. By arguing that a CTB will put a brake on nuclear weapons development, and thereby foster the objectives of arms control, these proponents are apparently committed to a CTB as a backdoor approach to nuclear arms control. But we must wonder whether such an oblique approach would resolve those very real political and military-strategic differences which have been the stumbling blocks in previous strategic and theater arms control negotiations. These differences appear to be one reason why it has not yet been possible to negotiate a CTB. Many of the same obstacles that have prevented significant nuclear arms reductions also stand in the way of agreeing to a CTB. If a way could be found to overcome those obstacles, it would probably best serve our arms control objectives to move directly to the negotiations of strategic and theater nuclear arms reduction agreements.

In the end, to focus on a CTB as the goal of arms control policy seems to me to work the wrong side of the problem. I cannot believe that a CTB can be a substitute for real nuclear arms control. Indeed, as Ambassador Stoessel suggested in testimony before this Subcommittee in February, the complete cessation of nuclear weapon testing is entirely rational only in an environment in which our dependence on nuclear weapons is reduced by agreements which successfully achieve substantial reductions of deployed nuclear weapons, and perhaps also by some level of non-nuclear defenses.

It is also questionable whether a CTB would significantly improve the non-proliferation regime. Domestic advocates of a strong non-proliferation policy, along with non-nuclear-weapon states, frequently argue that the failure of the superpowers to end testing provides a stimulus for other states to build weapons. They call for a CTB and point out that in the preamble to the 1968 Nuclear Non-Proliferation Treaty (NPT) the nuclear-weapon states recalled their determination to seek the cessation of all test explosions.

From a technical point of view a comprehensive test ban has only a marginal effect on the proliferation of nuclear weapons. Testing is not essential for designing and building the simple, first generation fission devices that a would-be proliferator is likely to want at the beginning of a nuclear weapons program. He needs only the money, the special nuclear material, and the knowledge and skills to assemble the device. Most, if not all, of the nations which have built nuclear explosives are believed to have detonated them on the first try. By signing a comprehensive test ban a would-be proliferator would not be depriving himself of the capability to develop nuclear weapons should he see these as essential to his national security or military ambitions. He would, however, be sacrificing the "prestige" or "warning" value he might see in carrying out a public explosion.

It is also argued that a non-discriminatory comprehensive test ban, signed by nuclear and non-nuclear weapon states alike, would inhibit the spread of nuclear weapons by making tests of nuclear explosives politically more costly than they already are. In the view of CTB proponents, conclusion of a comprehensive test ban treaty would demonstrate the United States' commitment to fulfill its obligations under Article VI of the NPT, which states: "Each of the Parties to the Treaty undertakes to pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament, and on a treaty on general and complete disarmament under strict and effective international control." With the NPT Review Conference approaching later this year, they argue that movement toward a CTB would prevent further erosion of support for the NPT and increase the attractiveness of the Treaty for "holdout" states.

While a CTB might--and I stress "might"--have marginal, short-term benefits for the NPT, it is unlikely to have a significant long-term effect on the problem of proliferation and the strength of the non-proliferation regime. It is unlikely that the states interested in building nuclear weapons are driven primarily by the "bad example" of the major powers. Like the nuclear powers, they are assuredly driven by their own security requirements. Thus, a comprehensive test ban is unlikely to prevent a country from deciding to develop nuclear weapons if it believes it can and should do so. Nor would it be likely to meet the goals of the non-nuclear-weapon states by bringing about general and complete disarmament or reducing the military superiority of the superpowers. A comprehensive test ban would not eliminate nuclear weapons, so it would not end the distinction between the nuclear and non-nuclear-weapon states. And it would not prevent the superpowers from developing new types of non-nuclear weapons equally out of reach of the present non-nuclear-weapon states.

The real and known technical costs of a CTB, then, appear more compelling than anticipated political benefits. It is certain that we must continue to test if we intend as a nation to rely upon nuclear forces in our defense posture, as we expect to do for the foreseeable future. As a laboratory Director, I have responsibility for overseeing the development of the nuclear weapons on which the US relies for deterrence and defense and am required to certify the performance and safety of many of the nuclear weapons in our stockpile. While I do believe that the current national security role assigned to Los Alamos National Laboratory could be performed under the TTBT, I would urge improved verification provisions. On the other hand, I have difficulty foreseeing conditions that would allow me to support a comprehensive test ban. I understand, perhaps as well as anyone, the awesome and dreadful power of nuclear weapons, and I believe that priority should be given to negotiations on controlling deployed warheads capable of inflicting harm. I share the hope that such talks will be successful.

Chairman FASCELL. Dr. Sykes, you may proceed.

STATEMENT OF LYNN R. SYKES, HIGGINS PROFESSOR OF GEOLOGICAL SCIENCES, LAMONT-DOHERTY GEOLOGICAL OBSERVATORY OF COLUMBIA UNIVERSITY, PALISADES, NY

Mr. SYKES. Thank you, Mr. Chairman, Members of Congress, ladies and gentlemen.

I address you today as a scientist who has been involved in research related to verification of test ban treaties for the past 24 years. I was a member of the U.S. delegation that negotiated the threshold test ban treaty with the Soviet Union in 1974.

I've also been a member of several U.S. Government panels that have examined questions of verification of atomic testing, including the yields of Soviet explosions.

Seismology, my main field of expertise, provides the main tools for verification of a comprehensive test ban and for ascertaining if the Soviet Union has complied with the 150 kiloton limit set by the threshold treaty.

First, I'd like to make the following major points:

Both the threshold test ban treaty [TTBT] and the peaceful nuclear explosions treaty [PNET] can be verified with high confidence.

Second, there is growing preponderence of scientific opinion that the Soviet Union has not violated the 150 kiloton limit of the threshold treaty. In fact, both the United States and the Soviet Union have tested repeatedly close to that limit since the treaty took effect in 1976.

Third, the TTBP and PNET call for extensive exchanges of data when the treaties are ratified. Those provisions would considerably enhance the verification capabilities of the United States.

Fourth, it is in the best interests of the United States that the Soviet Union not test large weapons. Ratifying these two treaties would constrain the Soviet Union by treaty from conducting such large tests. In the absence of such restraints, the U.S.S.R. would probably have an asymmetrical advantage in that it could conduct very large underground tests easier than the United States.

Fifth, a comprehensive treaty is verifiable with high reliability down to explosions of very small size. Recent advances over the past 2 years in seismology insure that clandestine cheating will be easier to detect that was thought only recently.

I believe that the main impediments to a CTBT are neither scientific nor technical but rest on the notion that U.S. security is best enhanced by continued testing and development of new weapons.

I would also suggest that an alternative to a comprehensive treaty is a very low yield threshold treaty with a threshold limitation of about 1 kiloton. Either that or a CTBT would drastically curtail the testing of a so-called third generation of atomic weapons.

Let me turn to Soviet compliance with the threshold treaty.

The United States capabilities for estimating yields of Soviet explosions, and hence verifying compliance with the 150 kiloton limit of the TTBT, have improved greatly over the past several years.

Dr. Jack Evernden of the U.S. Geological Survey, who has also worked in test ban verification for the past 25 years, and I organized a major symposium for the American Geophysical Union 2 years ago.

At that symposium about 500 people heard presentations on whether the Soviet Union was likely to have cheated on the TTBT and how well a comprehensive test ban could be verified. In that day about 15 experts presented their findings, including experts from the Department of Defense, the Lawrence Livermore Weapons Lab, and various Department of Defense contractors working in test ban verification.

There was a consensus among the participating experts, among those attending the symposium and in press coverage that the U.S.S.R. had not cheated on the threshold treaty. Also, scientists from the Lawrence Livermore weapons laboratory as well as those from the United Kingdom and Sweden who have done extensive work on seismic verification do not believe the Soviet Union has cheated.

It is now universally accepted that the correct methodology for estimating yields must take into account the geological and geophysical properties of the outer 100 miles of the Earth directly beneath various testing areas, as well as the properties of the rocks immediately surrounding each explosion.

All of the main Soviet testing areas are on old geological terrains, while most of the U.S. data come from Nevada, a region of recent earth movements and volcanic activity. If these geological effects are not accounted for, the estimated yields of Soviet tests are too large.

I believe that the allegations that the U.S.S.R. has violated the TTBT are—and I also believe that many other seismologists who have studied this problem believe, that those allegations arise solely from an incorrect calibration. The calibration that would relate the seismic waves and turn it into yields of explosions.

When the correct methodology is used it is evident that the Soviet Union has not cheated on the threshold treaty. In addition, it has complied with the peaceful explosions treaty by not detonating explosions above that limit.

The peaceful and threshold treaties both have extensive provisions for verification. The TTBT calls upon ratification for the exchange of data on geological and geophysical properties of testing areas, and for information to be released on the seizes of calibration explosions.

The TTBT states that weapons tests will be conducted at specific test sites. Those provisions will permit the United States to estimate yields of Soviet tests more accurately.

It is known that the sizes of seismic waves detected from explosions vary with the nature of the rock near the explosion point. The provisions of the TTBT were particularly aimed at giving a better calibration of that geological factor, that is, the properties of the material around each test explosion.

It should be pointed out that the United States already can estimate yields with high confidence. When the correct methodology is used it is evident that the yields provided by the Soviet Union for four of their peaceful explosions are correct and that they have not given us incorrect or misleading information.

The peaceful explosions treaty also has extensive verification procedures, including the first language allowing onsite inspections by U.S. personnel within the Soviet Union. That provision could be extremely important in other arms control agreements of the future, such as a comprehensive treaty.

I'd like now to address the question of verifying a comprehensive treaty. This is certainly one of the longest running items on the arms control agenda. Active interest in it now goes back more than 30 years.

Most seismologists who have been involved in test ban research, like myself, believe that the main technical and scientific impediments to verifying the comprehensive treaty were solved by 1968. The United States has spent about half a billion dollars in this area on research and instrumentation over the past 25 years.

Extensive negotiations toward a comprehensive treaty were conducted among the United States, the United Kingdom, and the Soviet Union from 1977 to 1980. An announced statement by the three indicated that all of the long-contested aspects of verifying such a treaty were resolved at least in principle by 1980, including a moratorium on the testing of peaceful explosions, provisions for U.S. seismic monitoring posts within the Soviet Union, exchange of seismological data, and on-site inspections of the challenge type. Those negotiations have been in abeyance since 1980.

Seismological methods are the main tools for verifying if a country has detonated clandestine underground explosions under a comprehensive test ban. The main problem in seismic verification has been to distinguish the signals of small explosions from those of the many small earthquakes that occur around the world every day. For the United States, of course, the Soviet Union is the prime country of interest in monitoring a test ban treaty.

In our October 1982 article in Scientific American, which I have passed out along with my testimony, Evernden and I made a special study of about 1,000 earthquakes and explosions on a worldwide basis. Once we had eliminated earthquakes outside of the Soviet Union or those deeper than about 15 miles, which is quite a bit deeper than the deepest wells that have ever been drilled, we were left with only a small number of events that were both shallower than 15 miles and within or close to the Soviet Union.

The remaining events constitute only about one-half of 1 percent of the world's earthquakes. In actual numbers this amounts to about 100 earthquakes per year equivalent in size to a 1-kiloton explosion in hard rock, and it's for those remaining events that we must use other diagnostic techniques.

One of the most important contributions of the U.S. program for research in this area was the finding in the 1960's that the excitation of seismic waves of various frequencies was different for earthquakes and underground explosions. Figure 3, on page 15 of my testimony, shows that the long waves from an earthquake are about a factor of 10 to 100 times larger than those from a nearby underground explosion. This ratio is highly reliable in allowing us to identify an event as being either an explosion or earthquake.

In the last 2 years it has been recognized that high frequency seismic waves propogate readily across large parts of the Soviet Union. With a high frequency capability and with seismic monitoring posts in the Soviet Union, as was agreed to in 1980, it should be possible with high confidence to verify even the most strenuous attempts to cheat at a level of 1 kiloton and larger.

Satellite surveillance and other national technical means available to the United States should be a powerful factor in verifying a comprehensive test ban since it would be exceedingly difficult to clandestinely dispose of the huge volume of material that must be excavated to muffle or decouple an explosion of even a few kilotons.

Chairman FASCELL. Unless you pump it full of Jell-O.

Mr. SYKES. Right. Removing that amount of material which for 8 kilotons fully decoupled equivalent to the size of the largest Egyptian pyramid, we are dealing with a huge volume of material that has to be excavated for that scenario to work. Nonetheless, all of us who are working on detection agree that the scenario of big-hole decoupling is the limiting factor in verifying a comprehensive test ban.

The United States has developed and tested instruments, so-called black boxes, that could be installed within the Soviet Union as part of a test ban agreement. Technology in that area has advanced to the point in which data can be transmitted nearly instantaneously by satellite to the United States. Also the devices can be constructed so that they will be tamperproof and we can be certain about the integrity of the data that they record and transmit back to us.

Two of the three reasons given by the U.S. Government in 1982 for not continuing negotiations toward the comprehensive test ban involved seismological data and methods. I have already argued that seismic and other verification measures are good enough to reliably monitor a comprehensive test ban down to explosions of very small size even if the Soviet Union tries its best to cheat. I've also argued that seismological data indicate that the Soviet Union has not cheated on the threshold treaty. I believe that focusing on those two issues displaces attention from several larger issues that deserve more extensive discussion.

Do the advantages of the comprehensive test ban outweigh the possible military disadvantages arising from possible clandestine testing at yields of a fraction of a kiloton?

Two, is the security of the United States or the Soviet Union decreased by a continuation of atomic testing?

And, three, does an adequate infrastructure exist within the U.S. Government to conduct a vigorous and thorough monitoring effort that will be needed under a comprehensive test ban?

Another argument against a comprehensive test ban has been that the Soviet Union could and would conduct very small explosions below the detection threshold of any seismic monitoring stations like those within the Soviet Union.

I've estimated that the identification limit is about 1 kiloton with U.S. stations on Soviet territory. That size of explosion is, of course, much smaller than the yields of weapons deployed on strategic systems today and well below the sizes of weapons that opened the atomic age in 1945. It is also well below the 5- to 10-kiloton size cited in congressional testimony in 1978 as being a test of military significance.

It is clear that arguments will continue to be put forth that the testing of very tiny weapons could be of significant military advantage, whether that is the case or not. Thus, I believe that a serious alternative to a comprehensive test ban treaty that would accomplish the same things would be a low yield threshold treaty with a limit of about 1 kiloton.

Relatively little attention has been focused on the disadvantages that are likely to follow if the 150-kiloton limit on the testing of weapons is not continued. Both the United States and the Soviet Union have had to conduct their very largest underground tests at very remote sites away from their main testing areas. That is, for the United States, Nevada and for the Soviet Union, central Asia.

Prior to the TTBT the United States conducted its largest tests at a very remote place called Amchitka in the Aleutian Islands, while the Soviet Union detonated its largest tests at its Arctic test site at Novaya Zemlya. The U.S.S.R. has continued to conduct some small tests at that second test site in the Arctic in conformance with the terms of the TTBT. The United States, however, has tested at Nevada after 1976 but not at Amchitka.

The United States could not conduct very large tests in Nevada without incurring damage in Las Vegas, surrounding communities, and possibly in Reno. Thus, in the absence of an agreement between the United States and the Soviet Union not to conduct very large tests, the Soviet Union could resume testing of weapons larger than, say, 1 megaton relatively easily while the United States could not do so very quickly or easily.

In summary, let me state that the threshold and peaceful explosions treaties are verifiable with a high degree of confidence. Both treaties call for extensive verification procedures, including upon ratification the exchange of data that would permit more accurate verification.

There is a growing preponderance of scientific opinion that the Soviet Union has not violated the threshold treaty.

It is in the best interests of the United States that the Soviet Union not test very large weapons. Hence, it is very much in our interests that we ratify both treaties and reenter negotiations toward a comprehensive test ban treaty.

Chairman FASCELL. Thank you, Dr. Sykes. You are an eminent scientist, and you have presented us with a great deal of technical information, which I might add is corroborated by a whole host of other scientists. Moreover, on the political issues, five administrations and a whole host of people have supported a comprehensive test ban treaty.

I was surprised that, as a scientist, you would be willing to step right out there and take a political position. That is great as far as I am concerned. Nevertheless, we are faced with the proposition that not all scientists agree. Therefore, those who oppose ratification of the threshold test ban treaty and the peaceful nuclear explosions treaty and those who oppose a comprehensive test ban treaty are going to cite all of the opposing scientific evidence to support their position.

So I am afraid that no matter how eminent you are and how much I believe you, that there will be people who will not believe you and who will roll out a whole bunch of scientific evidence about how technically it is impossible to verify anything.

That is the nature of the beast. But I think that the mass of scientific evidence if it were weighed along with commonsense would come down on your side if it were not for political decisions. But that is neither here nor there, and I do not think that we can decide that.

But I am intrigued by this issue. The United States as a matter of policy, quite aside from all of the technical mumbo-jumbo which everybody loves to quote all of the time, has decided to abide by the two treaties, but refuses to ratify them. At this time, the President does not want to send them to the Senate for ratification because he says that it is not in the best interest of the country which is a subjective judgment.

What I do not understand, however, is this: We say, according to Dr. Kerr, that we cannot verify, whether or not within the limits of the test ban treaties that a violation has occurred that the range is too high or too low, or that the calibrations are inaccurate, et cetera, et cetera. But we continue to adhere to the test ban treaties and we are perfectly willing to accuse the Soviets of lying. Therefore, the assumption, I assume, is that the United States is not violating the treaties; otherwise we would have heard from the Soviets.

The Soviets on the other hand are abiding by the treaty, because they seem to be quite confident that the verification suits them all right. And that leads me to ask: is the Soviet capability for verification better than ours?

Mr. SYKES. We certainly know from the negotiations that we had in 1974 that the Soviet Union has a number of seismologists working for their Defense Ministry, and that they have an extensive seismic monitoring system obviously aimed at the United States. But of course, aimed at other countries like China that they are very concerned about as well.

Of course, there are other symmetries in terms of the accessibility of the United States. And people from other countries can get much closer to the Nevada test site than the United States or foreigners can get to the Soviet test sites.

Chairman FASCELL. Well, I am also intrigued by the concept of the black box. We can put a black box on Soviet territory which the Soviets have already agreed to—if we ever get around to completing negotiation on the matter. Why, then, would that not be a good deal. It would be better than digging a hole next to the explosion, would it not?

Mr. SYKES. Well, I believe that, and I brought that up in conjunction with the comprehensive test ban treaty, that in fact probably the most important measure for the United States would in fact be to insist on having U.S. monitoring posts in the Soviet Union.

Chairman FASCELL. Well, would we have to negotiate on this?

Mr. SYKES. Well, in fact, that was one of the items which between 1977 and 1980 the Soviet Union did agree to have both United States and British seismic monitoring posts on their two countries, the exact number not finally decided. But that was one item on which they at least in principle agreed to that.

Chairman FASCELL. Dr. Barker, let me ask you a question.

Why do we bother to go through the hyprocrisy of abiding by the threshold test ban treaty when we do not want to ratify it, and we do not want to proceed; why bother, what difference does it make? If we think that our whole future is hung up on testing and accelerating with new generations of equipment why then, do we fiddle around with it?

Mr. BARKER. Mr. Chairman, Dr. Kerr in his testimony indicated that, at the moment, the directors of the Nuclear Weapons Laboratories believe that they can meet U.S. security requirements while adhering to the 150 kiloton threshold.

Chairman FASCELL. What does that mean, you do not need a new generation?

Mr. BARKER. I will defer to Dr. Kerr to amplify on his comments in that regard. But I think that it is important to remember that we are very, very hopeful that the Soviets will recognize and admit to the verification deficiencies and negotiate provisions by which we can adequately verify the TTBT.

Chairman FASCELL. But Dr. Barker, the resolution that we are talking about here asks the President to submit the treaties to the Senate, and allows him to add to the treaties whatever he wants to add to it in terms of verification.

Mr. BARKER. We have said to the Soviets "let us negotiate now." Last fall, the President reported the proposal in his U.N. speech. We think that it is fruitless to try to dictate to the Soviets the procedures which should be followed to improve verification. They must be negotiated by technical people from the Soviet Union and the United States.

Chairman FASCELL. I am not suggesting that, Dr. Barker, and the resolution does not suggest that. We are abiding by the treaty anyway. All we are saying is why not ratify it and if we have any reservations about verification just say we have reservations about verification. They're going to have to be negotiated.

Mr. BARKER. There is no if about it, Mr. Chairman. We do have reservations about the ability to verify this treaty.

Chairman FASCELL. I understand that.

Mr. BARKER. Let me correct the record on an earlier point in your exchange with Dr. Sykes.

The Soviet Union routinely protests to the United States that we exceed 150 kilotons——

Chairman FASCELL. Oh, that was just a scenario that I drew up. It's not based on fact, and Dr. Sykes didn't agree or disagree.

Mr. BARKER. I think the fact that they do protest adds further fuel, adds further support to the necessity for the negotiations of improved verification provisions.

Chairman FASCELL. We've both got problems then. We're both insisting that we're abiding by it. We're both accusing each other of violating it. If that isn't hypocrisy I don't know what is.

I'm not blaming you. I'm not condemning the United States. I'm just saying it's a ridiculous situation.

Mr. BARKER. We have tried to establish a standard of effective verification in all treaty areas across the board. We don't believe the threshold test ban treaty is the place to cave in on that—to give up on that standard as soon as we can negotiate with the Soviets an effectively verifiable provision we will be ready to——

Chairman **Fascell**. Now, you know the way that translates to me, sir, based on your statement with respect to the national policy?

Mr. **Barker**. No, sir.

Chairman **Fascell**. It seems you're saying that we should not have any treaty at all and that we ought to go on testing for bigger and better weapons because the national security of the United States depends on us being in better shape nuclearwise than the Soviets. Now, that's what it means to me.

Mr. **Barker**. As a representative of the Arms Control Agency, my hope is that we can get the Soviet Union to agree with us and to actually have——

Chairman **Fascell**. I blame them ahead of everybody. You know, I blame them for everything, including a bad peach crop in Georgia, but this logic escapes me. I'm sorry to have to say that. I'm not blaming you and I'm not blaming the United States. I'm just saying that we find ourselves as a nation in a ridiculous position with the Soviets because we don't trust them and they don't trust us. Yet we have two treaties that seek to put a limit on nuclear explosions and that seek a deceleration of the arms race, which we say we're abiding by, but our policy is that we can't be and shouldn't be bound by these treaties because they're impossible to verify. Therefore, what we are going to do is build bigger and better, ad infinitum. That's the way I read it.

Mr. Broomfield.

Mr. **Broomfield**. Thank you, Mr. Chairman.

I want to say at the outset that I appreciate having Dr. Kerr and Dr. Barker here to provide some balance to these hearings.

There is two sides to them and I would suggest to Dr. Sykes that he might want to read the testimony of Ambassador Walter Stoessel appearing before this committee on February 26. He doesn't agree with you a bit, and he was a chairman of that group you served on on the treaty. You might find it very interesting to read his testimony.

And, furthermore, Mr. Chairman, I don't even know why in the hell we got this before us. I thought, reading this bill, it's a Senate matter. If this is sense of Congress that's one thing, but just read the resolving clause.

"Resolved by the Senate and the House of Representatives of the United States of America assembled that as near as possible the President of the United States should request advice and consent* * *."

Who has advice and consent on treaties? We don't have it.

Chairman **Fascell**. Are you asking me to answer your question?

Mr. **Broomfield**. Yes; yes, I am.

Chairman **Fascell**. I'd be glad to answer a question.

I think it would be very useful to pass a law asking the President to send the treaty down to the Senate so the Senate could act on it.

Mr. **Broomfield**. Why wouldn't it be a sense of Congress resolution?

Chairman FASCELL. Well, the Senate passed that last time and——

Mr. BROOMFIELD. And, what happened to it?

Chairman FASCELL. [continuing] President didn't pay any attention.

Mr. BROOMFIELD. Oh, no; no, no; I'll tell you what it was. It was an amendment to the DOD authorization bill last year.

Chairman FASCELL. But, it was adopted by the Senate.

Mr. BROOMFIELD. As an amendment, and what happened? In conference they pulled it right off.

Chairman FASCELL. Well, I don't know about that.

Mr. BROOMFIELD. Well, anyway——

Chairman FASCELL. I mean, the Senate said, please send it down to us.

Mr. BROOMFIELD. It looks to me like we're headed for another nuclear freeze question on the floor of the House.

But, I want to ask a couple of questions here, if I may.

In regard to the comprehensive test ban negotiations, Ambassador Stoessel stated before the committee, and I want to quote:

> I feel that on certain things condemning verification technology plus the Soviet's record of violation make it inadvisable to proceed—to bilateral negotiations or resume trilateral with the United Kingdom in negotiation for CTB with the Soviet Union.

Now, I ask Dr. Kerr and Dr. Barker, given the record of the Soviet noncompliance with arms control agreements, including the ABM agreement, the Soviet invasion of Afghanistan, the Soviet deliberate shooting down of a Korean airliner and the Soviet killing of an American military officer, as well as the persistent question over verification technology, why should this committee approve House Joint Resolution 3, which urges approval of a threshold test ban treaty and peaceful nuclear explosion treaty, and most importantly, instructs the President to immediately be in comprehensive test ban negotiations with the Soviet Union.

The very same CTB negotiations were cut off with the Soviets by Jimmy Carter. What has changed since Jimmy Carter cut these negotiations off?

Mr. BARKER. The administration would clearly like to see congressional endorsement of the administration's request of the Soviet Union to improve the verification provisions of the threshold test ban treaty before moving on to consideration of other treaties of the nuclear test limitation type.

We do appreciate the congressional support that has been given to what the administration considers its highest priority, namely negotiations which will give rise to radical reductions in the number of nuclear weapons.

We believe that these are well thought through, carefully considered positions taken by the administration and hope that the Congress can join us in seeking their achievement.

Chairman FASCELL. Dr. Kerr.

Mr. KERR. I think my view at the moment is that the issue of ratification of the threshold test ban treaty and PNET, first of all, should be separated from that of instructing the President to proceed with the CTB.

They are different matters. One involves treaties that have been signed but not ratified. The other involves decisions that need to be debated not in the context simply of whether they can be verified or not, but in fact whether our national interest presently is in pursuing a CTB with all due speed or whether it should await a climate perhaps produced by success or compromise in the three other negotiations that are ongoing in Geneva.

Those negotiations in fact address three different types of armaments, some of them nuclear, the majority in fact, and the outcome of those negotiations might in large part guide our future views about the need for modernization of our nuclear forces or not.

If there were a need to modernize, the comprehensive test ban would be incommensurate with that need, and that was the point I was trying to make.

A second point that I would raise—and it really goes back to the chairman's question about whether it would be better to have more seismic verification capability or have a CORRTEX hole which might be seen as more intrusive, and there I'd like to use a historical event to make my point.

Back in September 1979, there was the famous flash of light that was observed, perhaps from the South Atlantic. There were several committees formed but for the sake of the argument, I'll say there were two—one made up of people who had long experience with observing flashes of light from nuclear explosions and who immediately concluded that it must have been a nuclear explosion—and another committee comprised of people with great expertise but not much experience in that area, that immediately went to work to find all of the other possible explanations.

The difficulty for both committees and the U.S. Government was that there was only one piece of data; it was questionable data in terms of the way it was obtained, the calibration of the instrument, the state of health of the satellite. And on the down side, the political consequences of concluding that it might have been a nuclear explosion were unacceptable based on little bit of data.

So, I'd make a very strong argument that if one does seek enhanced verification one seeks it not by simply expanding a single technique but adding a second one that couldn't be spoofed or misinterpreted in the same way.

Chairman FASCELL. I'll buy that. I'm ready to see all of these things sent up here. I'll approve them today, if the administration's got them on the plate.

Mr. Berman.

Mr. BERMAN. Thank you, Mr. Chairman.

I think it should be pointed out that at the last hearing Ambassador Stoessel, a number of times, indicated that he was not a scientist and, essentially, the conclusions that he had reached in his testimony were based on certain scientific information he had received, not based on an independent evaluation or verification of any of these things. I think there was some surprise actually at the thrust of his testimony at that time.

I'd like to ask Dr. Kerr: Assume for a second there is the ideal verification, but nothing has been worked out in Geneva so that the strategic arms race continues. Negotiations and the consummation of a comprehensive test ban treaty would affect modernization of our forces and the survivability of our weapons. Where would you come down in terms of the wisdom of the United States proceeding to negotiate a comprehensive test ban treaty in the absence of an agreement in Geneva?

Let's just keep verification out of it.

Mr. KERR. Understood.

In fact, in speaking to you earlier, Mr. Berman, I tried to make it clear what testing means in terms of weapons development, what the role is, what things we could and could not do if we were denied the opportunity to test.

Mr. BERMAN. Well, Dr. Sykes, I think, in his testimony, indicated we would not have the MIRV'd missiles, we would not have the antiballistic missiles, we would not have the MX missiles, we would not have the cruise missiles, and the Soviets would not have the counterpart weapons if we had not had testing for modernization purposes.

Is that accurate?

Mr. KERR. Well, I think that's an interesting point, but in fact the world we live in and confront today has all of those things in substantial numbers.

Now the question that really lies on the table, once you have removed the verification issue, is what is it the United States needs? And, I would argue that the negotiations in Geneva have a lot to do with our view of that future and it would be wrong to take up the matter of a comprehensive test ban, which is a limit on the long-term development possibilities, before the more important issue of the number of weapons that hold you at risk is dealt with.

Mr. BERMAN. Well, let's turn that around for a second.

Assume you had a comprehensive test ban treaty and, therefore, essentially, an inability to do the kind of modernization that produces new weapons. Might not the atmosphere improve for achieving the significant reduction in strategic offensive weapons? Might not the need to research, test, and deploy a strategic defense initiative, be seen as reduced in that context? Couldn't act B create an atmosphere that would be more likely to produce success on the strategic arms negotiations front, and therefore reduce any need to modernize?

Mr. KERR. I understand your question, and you're really introducing a question of time. And, my feeling about that is that the time for those affects to be felt seriously in terms of our force structure would be long compared to what I'll call political lifetimes which tend to drive the urgency with which we negotiate. And, you know, whether you measure that in your term of office or a Senator's term of office, it's a different thing than the technical issues that would face those who are responsible for the maintenance of the stockpile.

Mr. BERMAN. I'm assuming Dr. Barker had questions in his testimony on your assertions on Soviet violations—I think your words were "It's likely they were violating the agreement."

If you had the verification permissible under the Threshold Test Ban Treaty, would your ability to know whether that treaty was being violated be increased? You are apparently not getting certain data that you would be entitled to get if that treaty were ratified.

Mr. Barker. The President's conclusion on the Threshold Test Ban Treaty is very, very carefully crafted. It acknowledges the fact that there are ambiguities. There are problems with the evaluation of Soviet nuclear weapon yields by the methods currently available to us. The President's conclusions are based on the totality of data, only a part of which is seismic. In the two compliance reports to the Congress, the 1984 report and the 1985 report—those other elements—those other nonseismic issues were detailed.

Mr. Berman. Would the additional information that would be provided were the treaty to be ratified help to ascertain with a higher level of certainty the conclusion?

Mr. Barker. I need to characterize that data for you. As I said in my formal statement, the TTBT, as written, is the most glaring example of verification by trust that I can think of. Upon ratification, the treaty calls for the Soviets to give us data—to tell us the yield of two historic Soviet events, to tell us where those two tests took place, and to give us certain geologic information about the Soviet test site. The treaty provides no mechanism by which we could independently confirm that any of that data is correct. For assessing its reliability, we are dependent upon a network of information gathered over the years by various and sundry intelligence sources, or information that may have appeared in the open literature.

But, there is no mechanism provided in the treaty by which we can validate any of that data and that is the objection of the administration to that treaty. We want the ability to independently corroborate that the data that we are to use for calibration is correct.

Mr. Berman. I've taken up more than my time.

Chairman Fascell. I'm smiling, Dr. Barker, because sooner or later I'm going to come back to you.

Mr. Hyde. OK.

Chairman Fascell. I'm not just going to leave that hanging out there. Mr. Hyde?

Mr. Hyde. Thank you, Mr. Chairman. The chairman referred to our adhering to the Threshold Test Ban Treaty, even though we haven't ratified it as hypocrisy, and in that way it is being used as a real excuse to continue to build bigger and better nuclear weapons.

It seems to me that if we retain the right to test and modernize our nuclear deterrernt, the weapons need not be bigger and better, they can be smaller and safer, and that's a very prudent direction in which to go. Time marches on.

Technology develops and develops and develops. No matter how many resolutions we pass, the state of the art is always changing. Now, if mutual assured destruction is the way to go, and I heard Secretary MacNamara, and I heard Secretary Clifford, etc., etc., say that has preserved the peace, it seems to me we have to maintain a credible deterrent. In order to do that—bombs must be maintained. They have to be replaced, they have to be modernized, and to do that without testing them is absolutely scientifically primitive.

Now, what bothers me is looking at this as a very complicated technical subject and trying to bring some common sense to it when you have respectable scientists on one side saying, "You can't adequately verify it."

You've got respectable scientists on the other side saying "Oh, yes, you can." But when I hear them saying they rely on the exchange of data with the Soviet Union given the Soviet track record on exchanging anything, including telemetry on the testing of missiles,—well.

If anyone would rely on the data they give you, it would be a subject for a thesis, perhaps for a degree in abnormal psychology. [Laughter.]

But notwithstanding that, as long as there's a dispute among the technical people as to whether you can verify or not, what in the world would make you want to put your faith and security and civilization in the hands of trusting them without being able to verify?

Now, I heard something else that Dr. Barker said. He said that we have sought to negotiate with the Soviets to improve methods of verification. Did you say that, Dr. Barker? And their response has been to refuse to sit down and negotiate to improve verification. Is that correct?

Mr. BARKER. That's correct.

Mr. HYDE. Why in the world would you take them seriously, then? If they don't want to improve verification, why in the world would you trust them about a comprehensive test ban treaty? No, if our deterrent—based upon mutually assured destruction is the way to go, then we'd better have a deterrent that's believable, and that means one that's modern, one that's safe, one that moves with the state of the art, and that means you have to test the weapons.

This is a backdoor nuclear freeze, and the people who want it are people who want the freeze and are content to let the Soviet Union maintain their SS–18's, their SS–23's, 24's, their whole range of modern intercontinental ballistic missiles, and leave us with our Minuteman 3 and our piddling few MX's, which God help us, we may never need. These same people think that this asymmetry is going to protect the world.

And I leave you with one of the real anti-Communists and a real cynic when it comes to the Soviet Union, Mr. Lantos.

Chairman FASCELL. I want to join him in the anti-lumping move right now that my colleague just engaged in, and I refuse to be lumped, which is what he just did.

Mr. HYDE. I don't know where I lumped you, Mr. Chairman.

Chairman FASCELL. Well, I am for the resolution, but that doesn't mean I agree with everything the Russians do.

Mr. HYDE. Forgive me. I am not personalizing any of this. I am trying to reach, in my meek and bungling way, logical conclusions. Now, maybe I'm wrong, and I'm somewhat uninhibited in drawing my conclusions, but I try to learn from history. I try to see what has been and predict what will be. Maybe I'm wrong.

Chairman FASCELL. I do the same thing. I am just saying, with tongue in cheek that I want to get unlumped right away. That's all. [Laughter.]

Mr. HYDE. I yield to Mr. Lantos.

Mr. LANTOS. I want to thank my friend from Illinois for yielding.

I have sympathy for his logic, but with one significant reservation.

I happen to be a professional economist, and we have professional economists testifying before the various committees, we have the more conservative ones and the more liberal ones, and they are all equally good and from equally respectable institutions.

There are always two sides of the argument. No one can explain that in very simple ways.

I think when they come to our arena, there is also sort of a cluster of scientists who are viewed as more liberal and a cluster of scientists whose view is more conservative, and if, in fact, the lumping that our distinguished chairman referred to would be lumping along vertical lines, I would find myself very much in tune with my good friend from Illinois, because there are more liberal scientists and more conservative scientists.

But as I look at the rest, I have a question that I would like to ask our administration witnesses, not necessarily asking to comment on each of these individuals, but comment on the cluster.

Mr. HYDE. I wonder if I might retrieve my time. I think I am down to the very end of my time and I think the gentleman has a very interesting——

Chairman FASCELL. Why don't you give him a little more time to finish his question?

Mr. LANTOS. I will be happy to. I would be most happy to, Mr. Chairman.

Mr. HYDE. I am near the end. Now, as I understand seismology, to measure the yield of a weapon depends not only on the displacements of the Earth, but that, of course depends on the geological characteristics of the Earth.

Is that not correct?

Mr. SYKES. That is correct.

Mr. HYDE. And I think it is in 100 miles from the explosion that is important; am I right?

Mr. SYKES. These are mainly waves that go straight down through the Earth, and so it is important to know how they are affected in that 100-mile segment.

Mr. HYDE. Now, how do you know that under present circumstances? Do you accept the data they give you or are permitted to go to the site and make on-site testing?

Mr. SYKES. We are not permitted to go to the site, but there are some other types of waves, and those have been extensively researched just in the last few years, called surface waves, that go out sideways. So that they are not affected by the path that goes straight down, for which the properties vary from place to place and is a function of old geology or young geology.

And, so, now I believe we have a good calibration on this other type of wave——

Mr. HYDE. Are you saying geological characteristics are now of lesser importance than they used to be?

Mr. SYKES. We feel that one type of wave that the United States has relied very extensively on in the past, I and others have advocated using these other types of waves, and I believe that scientific opinion is following in that direction that we should use not just one, but other types of waves, as well.

Mr. HYDE. Do you discount the geological characteristics then?

Mr. SYKES. No; so that we have information of that type and, for example, one of our other test sites, the one in the Aleutians appears to have properties for the transmission of these waves through the outer 100 miles which is very similar to the Soviet testing areas.

Mr. HYDE. Why do you think the Soviets have not cooperated on the development of improved verification methods?

Mr. SYKES. Well, I think there is a very long tradition in the Soviet Union to be secretive about things in general. And in this case, they have given us some information on a few peaceful explosions. Of course, the United States has released yields on a lot more tests than the Soviet Union has.

Mr. HYDE. Thank you.

Dr. Kerr, do you have any comment to add to what I have said or what Dr. Sykes has said?

Dr. KERR. I think as a matter of clarification, it might be useful for me to characterize the verification process as having two parts. One has to do with the measurement of a disturbance, whether the body wave magnitude that has been traditionally used for yield estimation, or surface waves that might be used in the future but are not used presently.

The first issue you have is can you detect the disturbance; that is, make the measurement at all? The second phase of it is interpretation and the relating to those magnitudes that you have measured with whatever errors may be inherent in the measurement in order to conclude something which has to do with verification.

The issues that tend to divide the community are not so much on the side of can you make the measurement, as I understand it. The community of seismologists knows what they can measure and under conditions where they understand the geology, they can tell you with what errors they might be able to make that measurement, the accuracy of it.

The place where there is disagreement is in the relationship of those seismic measurements, the amplitudes that are related to the yield, which in the absence of setting off a device of our own at their test site or being able to do substantial geological investigation rests on data that would be provided by the United States. A better approach would be to find other means to use so that we would have a separate and independent measurement.

So, I do not think people should take from this discussion that there is great doubt about seismic science or the people that do it, but there is a difference in opinion on how those seismic measurements are related to yields, particularly when we don't know the test configurations, and when the Soviets test at many different locations which have different geological properties.

Chairman FASCELL. Dr. Kerr, let me ask you a question. Do you have any trouble carrying out your responsibility of knowing when the Soviets have conducted a nuclear test explosion?

Mr. KERR. In general, the seismic network that the United States operates has detected tests.

Chairman FASCELL. So, you know when the Soviets fire one underground.

Mr. KERR. There have been Soviet tests that have not been detected seismically.

Chairman FASCELL. So, you don't believe explosions could be detected down to one kiloton.

Mr. KERR. It varies from place to place in the Soviet Union. I do not disagree with the point that with hard rock coupling, some level like a kiloton would normally be detectable. All I am saying is that there has been at least one occasion where a Soviet test has not been detected seismically.

Chairman FASCELL. In what, the last 20 years?

Mr. KERR. More recently than that.

Chairman FASCELL. More recently. Well, then you must have other means of verification. They're called moles, and, you know, moles get in the ground, they run around—et cetera. [Laughter.]

I understand, you cannot compromise your sources of information.

How about 150,000 tons, if they fire off one of those babies, would it shake up your laboratory?

Mr. KERR. We are not in the seismic detection businesss at the laboratory, but the answer——

Chairman FASCELL. Somebody has the responsibility.

Mr. KERR. Yes, sir. The point is 150 kilotons would be detected.

Chairman FASCELL. So, you don't do all this measuring.

Mr. KERR. No, sir.

Chairman FASCELL. Does ACDA do it?

Mr. BARKER. As in all treaty areas, the intelligence community has the responsibility——

Chairman FASCELL. Oh, boy, I knew it was someone else. Now, we have everybody but the right people here.

Mr. KERR. Well, to clarify it a bit, we do work on the interpretation side. We are not the collectors.

Chairman FASCELL. Well, let me ask the question that way. You work on the interpretation side. Do you mean to tell me that an intelligence agency has the responsibility to collect the seismic data, make the preliminary raw interpretation and turn it over to you for final?

Mr. KERR. The intelligence community is a more highly integrated thing than that.

Chairman FASCELL. Well, I realize that.

Mr. KERR. But, in fact, our laboratory, the Livermore Laboratory——

Chairman FASCELL. So you double check them——

Mr. KERR [continuing.] Community.

Chairman FASCELL. You are part of the community, are you not?

Mr. KERR. Yes, sir.

Chairman FASCELL. Well, what do you do when you disagree with a collector?

Mr. KERR. The collector doesn't make the interpretation.

Chairman FASCELL. So, you make the interpretation with five or six other guys in concert. I got you.

Mr. BARKER. Mr. Chairman, may I clarify the Government's process a little bit?

Chairman FASCELL. That would be healthy. [Laughter.]

Mr. Barker. The intelligence community gathers the data bearing on the Soviet Union's nuclear testing from whatever mechanisms it has available to it.

Chairman Fascell. I was not interested in nonseismic at this point.

Mr. Barker. The President's conclusion, however, that the Soviets have likely violated the treaty is based upon more than seismic data.

Chairman Fascell. I am trying to find out now who gets the seismic data. Who decides there is an explosion? Somebody has got to say, "Hey, call a meeting, they have exploded something." Who does that?

Mr. Barker. There is a group, an interagency——

Chairman Fascell. Working group.

Mr. Barker. An intelligence community group which meets——

Chairman Fascell. All right, and they have that responsibility. So, somebody has his eye on the needle, and the needle jerks and he says, "Oh-oh, call a meeting."

Mr. Barker. Correct.

Chairman Fascell. Next, a piece of paper would come across his desk and he says, "Hey, we had better call a meeting."

Mr. Barker. A statement is then issued to the rest of the Government saying that a test has occurred, correct.

Chairman Fascell. So, somebody knows someway, somehow.

Mr. Barker. We know what we have detected, correct.

Chairman Fascell. Yes, right.

Mr. Kerr. Specifically, sir, there is the Joint Atomic Energy Intelligence Committee which oversees those elements of——

Chairman Fascell. Well, you are not concerned about that. You are satisified that this process is a great process. What you are concerned about is interpreting that a shot has gone off and determining what the yield was.

Mr. Kerr. That is correct.

Chairman Fascell. And if I recall what your statement was with any accuracy, there is no way to do that——

Mr. Kerr. What I——

Chairman Fascell. With reliable accuracy?

Mr. Kerr. The range of values as a consequence of uncertainties in the geologic medium, uncertainties in calibration is such that it often overlaps that yield range that is not permitted under the treaty by itself would not allow you to ask——

Chairman Fascell. So, let me put a number out there for you, okay? Excuse me for taking this time but I have to nail this point down.

So, 150,000 is the limit, there is an explosion and all the community gets together and they look at all the instruments and all the little pieces of paper and they say, "Well, this test could have been anywhere from 75,000 to 300,000." Is that an accurate statement?

Mr. Kerr. That would be a reasonable statement, yes.

Chairman Fascell. And, therefore, the Soviets have violated the treaty.

Mr. Kerr. No, you have to ask the second question.

Chairman Fascell. Which is?

Mr. KERR. Which is what is the probability that the yield might have been above.

Chairman FASCELL. Why bother to ask that? We do not trust the Russians anyway.

Mr. KERR. Well, but that——

Chairman FASCELL. So, any explosion has got to be a violation.

Mr. KERR [continuing]. Is whether they have complied.

Chairman FASCELL. Yes.

Mr. KERR. What you have demonstrated through this point is that you cannot answer that question with the seismic data alone.

Chairman FASCELL. Yes.

Mr. BARKER. Mr. Chairman, I think——

Chairman FASCELL. But there are other ways of finding out.

Mr. BARKER. Occasionally.

Chairman FASCELL. Yes.

Mr. BARKER. Any single test presents exactly the problem that you have suggested. You want to know what the yield is within some range. However, if you watch the program over several years and see many tests come in with an average yield substantially above the threshold, doubts are created, and when you take a look at the totality of the data, you can come to the conclusion of a likely violation.

Chairman FASCELL. If you assume that everybody is testing at 150,000, for example, and all the best estimates you can get, seismologically and otherwise, are somewhere in the range between 75,000 and 300,000, and then all of a sudden an explosion jumps to 750,000, you have a different conclusion, have you not?

Mr. KERR. Very much so.

Chairman FASCELL. Yes. You do not have to be a genius to figure that one out. so, if testing went along for 20 years within the same range, between 75,000 and 300,000, you would know pretty much what you are dealing with.

Mr. BARKER. You would conclude they were testing at the same level.

Chairman FASCELL. Yes. That is what I meant.

Mr. BARKER. What that level is, you do not know because you cannot——

Chairman FASCELL. What difference does it make? They keep building bigger and bigger and bigger and bigger missiles and delivery and capability is more accurate and they have greater throw-weight; what difference does it make?

Mr. BARKER. Dr. Kerry——

Chairman FASCELL. Of course, what you are saying to us is that we want to go the same way, we want the same thing. We want to be able to test all kinds of new designs, go to lesser throw-weight, or more throw weight, or smaller holes, or bigger holes or——

Mr. BARKER. Mr. Chairman, we want that treaty ratified. We want the treaty effectively verifiable.

Chairman FASCELL. Well, just tell us what you want and we will effectively verify it. [Laughter.]

Mr. Hamilton.

Mr. HAMILTON. Dr. Barker, is it your view now that Presidents Nixon and Ford jeopardized the national security when they asked for ratification of these treaties?

Mr. BARKER. As I indicated in my testimony, I think that at the time when those decisions were made there was a sense of optimism that does not exist at the current time. In that timeframe in 1974, I think people were optimistic that the science of seismology would allow us to understand and determine Soviet yields with much higher confidence than when first——

Mr. HAMILTON. In 1984, you are now asking whether what was done in 1974 would have jeopardized the national security, obviously.

Mr. BARKER. The nature of the question has escaped me somehow.

Mr. HAMILTON. From your perspective in 1984, looking back on it, the requests of Presidents Nixon and Ford at that time would have jeopardized the national security of the United States; is that not right?

Mr. BARKER. I hope this answers your question. Right now the United States is adhering to the terms of the threshold test entry, despite the fact, as the chairman has noted, that we are indeed concerned that the Soviets are not living up to that commitment. We have not abandoned the threshold test treaty ourselves and are continuing to seek——

Mr. HAMILTON. When they made that request, do you think it was a request that as consistent with the national security of the United States?

Mr. BARKER. At the time I am convinced they were absolutely convinced that the request was——

Mr. HAMILTON. Did you think that?

Mr. BARKER. At the time?

Mr. HAMILTON. Yes.

Mr. BARKER. At the time I had no reason to doubt that judgment.

Mr. HAMILTON. Yes, and that would have been the judgment of the scientific community, as well, at that time?

Mr. BARKER. I think that the scientific community that was consulted apparently agreed with that conclusion, yes.

Mr. HAMILTON. I am interested in the nature of this difference. These are just extraordinary statements that you have put forward.

Mr. Sykes, you say that both treaties can be verified with high confidence. Your statement is unequivocal, flat, clear.

However, Dr. Barker says these treaties cannot be effectively verified. And Dr. Kerr a moment ago was trying to explain the difference. I am not sure I understood it completely. What really is the nature of the difference between you, that with your pedigrees in science and skills that I know you possess, you can come in here and give us such astounding different conclusions? You are not even close to one another.

Mr. BARKER. Let me at least give a distinction and let Dr. Sykes explain where he fits in that spectrum. I think it is important to remember that I used the words "effective verification" in that regard. And that statement is fundamentally, as the chairman recognized earlier, a political statement. There is technical capability to measure yield within some uncertainty. That is the technical——

Mr. Hamilton. And there would be agreement on this among all scientists; is that right?

Mr. Barker. There would be agreement among all scientists that certain signals can be measured to a certain accuracy. The yield that one associates with a given signal is a somewhat different issue.

But over and above that, there is the issue of whether that uncertainty is compatible with the military and political interests of the United States. And you can in that area get into subjective judgment. One man can feel that a very large uncertainty is not in any way jeopardizing the national security of the United States, and someone else can feel that very precise number is required in order to be consistent with national security.

And, so, I think it is important to make clear whether one is making a technical statement or a political statement. I assumed or hoped that Professor Sykes was making a technical statement which I do not quite understand about the precision of measurement.

As soon as one goes beyond the technical statement, one is going into political domain in which many people may come to very difffernt opinions based upon the same hard technical data.

Mr. Hamilton. Maybe Dr. Sykes could comment on that, the nature of this difference.

Mr. Sykes. That is right. I think it is important that very often we have heard statements made about capabilities without coming to terms with just how large the uncertainty is. And, of course, with any scientific measurement, there is always going to be some uncertainty. And the question is, of course, is that something you can live with or you cannot.

For example, the group of seismologists present in Moscow for negotiations in 1974, five of us, gave an assessment at that time of what the uncertainty would be either if we have the data package from the Soviet Union and can trust it completely versus the situation if we only had our own data at the time.

I believe we have now reached the point 11 years later when, in fact, we are able to determine yield with about the same uncertainty that we would have—that we predicted 10 years ago that we would be able to do if we, in addition, had that complete data package and trusted it completely.

In fact, I think that the technical arguments are now down to arguing about differences in the scale of determining yields of about 30 percent, whereas, we have seen comments that have been made in the newspapers, some that have appeared in scientific literature, that would indicate that the Soviets might be testing two, three, five times the agreed upon limit of 150 kilotons.

I do not believe that there are any serious representations or data to substantiate such big amounts of cheating by the Soviet Union. In fact, all of the disagreements are about where you put that scale in terms of about the 30-percent level.

Mr. Hamilton. How do you respond to Dr. Barker, and I think Dr. Kerr's statement, as well, that these are really two steps here in the verification process? There is the measurement step in which there would be presumably unanimous agreement among scientists what the measurement shows. And then there is the interpretative step. Dr. Sykes, how do you respond to that? Are you saying that these treaties are verifiable with a high degree of confidence? What kind of leap, if you will, are you making with regard to interpretation?

Mr. SYKES. Right. For example, I would agree that when we measure the basic size of these wiggles on seismic records that I do not think anyone has any serious doubt that we can determine that an explosion has gone on and that we can measure the size of the wiggles. The interpretation comes in converting that into a yield of explosion, and that is, in fact, where the disagreement has been.

But what I am suggesting to you is, in fact, that all of those comments by people who have claimed that the Soviets have violated the treaty by a large measure come from an incorrect calibration. And I think that the scientific community has centered now on arguing about differences of about 30 percent. We are no longer having serious arguments about a factor of 2 or 5, for example. And if we were worrying about a factor of 2 or 5, that would, in fact, be a very serious matter.

Mr. HAMILTON. I am not sure I understand why you would think that Dr. Barker and his colleagues are wrong when they say it cannot be effectively verified. What makes you think they are wrong when they say that?

Mr. SYKES. Well, this goes now to one type of measurement. I do not think that there is serious disagreement about the individual measurements. But, on the other hand, we do have two primary types of ways, and a number of people have emphasized using only one of these. I for 15 years, and others, have argued that we should use both of them, and use both of them effectively.

One of these are the surface waves that we have heard about. The scientific community has seen a large effort put into how do you do the calibration of yield with surface waves, and I believe that we now have an effective answer to that. That, of course, then feeds back into does it give the same answer with the other method, or do we then have the geological factor incorporated correctly. The decision to use that data, the surface wave data, is a very important decision. Right now I think that seismologists agree that we can get a good answer using them, but the official way in which the United States goes about converting the size of wiggles into yields uses only one of these methods and it does not use surface waves.

Mr. HAMILTON. In the law business they talk about the weight of authority. Among the seismologists in the country, do you represent the weight of authority in saying that these treaties can be verified with a high degree of confidence, or does Dr. Barker represent the weight of authority, or is there a dispute about who represents the weight of authority?

Mr. SYKES. One thing that I mentioned in my testimony was that there was a major symposium 2 years ago for the American Geophysical Union in which about 15 experts spoke on this subject, and we did hear people, then, from the Defense Department, from the Lawrence Livermore Lab, and of those 15 people or so who spoke, the opinions were quite unanimous, and I think there was only one person that believed that the Soviet Union had cheated on the threshold test ban.

So, at least I feel that a scientific society went about choosing a group of experts, I think, of a wide variety of opinions.

Mr. HAMILTON. Dr. Barker, do you want to comment on that?

Mr. BARKER. Well, first, I want to disagree with Professor Sykes' conclusions about his own conference. I think there were quite a few people there who concluded that there was insufficient information to determine one way or the other whether the Soviet Union had cheated, as opposed to a large number who decided the Soviets were in compliance with their obligation.

But I also wanted to note for the committee's recollection that Professor Sykes, in addressing the issue of verification, continued to talk about technical issues. No matter what the level of uncertainty is, there is still the issues of military and political risk to this country from a treaty which has certain limits to the ability with which it can be verified.

When Professor Sykes is making the statement, "It can be verified with high precision," I am concerned that most people think he is saying it can be verified to a level which is compatible with the security interests of this country.

When he makes a statement like that, he is going well beyond his expertise in seismology and stepping into a domain in which many, many other people have equal authority. So, I think——

Mr. HAMILTON. You are really, in a sense—I suppose there are always—there is always an element of risk, I presume, to any verification procedure.

Mr. BARKER. Always.

Mr. HAMILTON. Somewhere.

Mr. BARKER. Perfect verification is beyond us.

Mr. HAMILTON. Yes.

Chairman FASCELL. Unless you are sitting on top of an explosion. [Laughter.]

Mr. BARKER. Even then you may not know how big it was. [Laughter.]

Mr. HAMILTON. The problem, I guess, is you have to weigh that risk against the risk that is present when you do not have the constraint that the treaty provides.

Mr. BARKER. Exactly, Congressman.

Mr. HAMILTON. Mr. Chairman, the witnesses have been very good and very helpful. I have appreciated their testimony, all three of them. Thank you, Mr. Chairman.

Chairman FASCELL. Mr. Leach?

Mr. LEACH. Thank you, Mr. Chairman.

I think we have had several perspectives that ought to be stressed, and particularly Dr. Barker's perspective that the difference between 1974 and 1985 is partly the political climate, not just the scientific environment. I mention this because we have not only an example of abnormal psychology, as my good friend Mr. Hyde has mentioned, but of abnormal politics. After all, my colleagues on the other side today have largely represented the perspective of the foreign policy of two Republican Presidents.

And with regard to this measure, the majority of Republicans in the other body supported it as an amendment that passed the Senate of the United States.

And, so, in terms of politics, we are not dealing with something partisan but rather something deeply rooted in both political parties.

Having said that, it strikes me as awkward that somehow it is wise policy to agree to abide by the TTB and PNE treaties but not ratify them, therefore decreasing our capacity to measure the other side's activities.

And, Dr. Barker, can you tell me why it is smarter not to have access to the admittedly modest provisions of further verification by refusing to ratify? Is that smart politics? Is it smart science?

Mr. BARKER. What we have seen and what we are seeing is the determination made 4 years ago that the Threshold Test Ban Treaty is not effectively verifiable. Immediately upon coming to that conclusion, the administration approached the Soviet Union seeking to improve verification provisions of that treaty so that the President could, indeed, seek the advice and consent of the Senate in its ratification.

It is our opinion that the information which would be gained by ratification is of so little significance as far as addressing our major problems, as far as the verification is concerned, that we must—we are compelled—not to give up the standard we have espoused, the standard of effective verification.

Mr. LEACH. Let me go back to the standard of effective verification.

Mr. BARKER. Yes.

Mr. LEACH. The United States of America has spent $500,000 alone in this issue of verification of underground tests. Has that provided you anything? Are we not in a better position, as Dr. Sykes has indicated, in 1985 than we were in 1974 and 1976, when the two treaties were ratified? And how much more do we have to spend to be in a position of effective verification? Is it another $500,000? Is it time frame 1 year, 5 years, 15 years, or is it exclusively a judgment of political climate?

Mr. BARKER. I think you have asked a question that may require more technical expertise in the area than I have to answer. No study on our part is going to provide us with the ability to calibrate the Soviet test site. To do that, we have to know the yield of some number of events that actually took place there. So, we can continue to spend a lot of money on research. That is not what is going to get independent calibration data.

On the other hand, I think it would be very unfair to say that this $500,000 that has been spent on research has not accomplished a great deal. Dr. Kerr made the point about the——

Mr. LEACH. Should we stop spending it?

Mr. BARKER. I think we certainly should not stop spending it because I think there are significant improvements yet to be made that may bear on the ultimate verifiability of a comprehensive test ban treaty.

Mr. LEACH. Let me provide a perspective. Your agency comments on the number of arms control initiatives. Of all those arms control initiatives, recognizing perfect verification is impossible, is it not true that underground explosions are about the most verifiable aspect of arms control today? Is there another aspect in the serious treaties that is more verifiable? And if you come before this Congress and say you cannot have any treaty in this area because of lacking capacities for perfect verification, will we never be able to have any arms control of any kind in any area of substantive significance? Is that a possible conclusion?

Mr. BARKER. I agree with you entirely that no treaty area is perfectly verifiable, and I do not expect to see anyone from this administration testifying that a treaty is not verifiable because it is not perfectly verifiable. We are always dealing with levels of uncertainty, and the question is whether those levels of uncertainty are commensurate with the national security risk to this country.

In the case of the Threshold Test Ban Treaty, we believe that if the Soviets are serious about arms control, there should be no impairment to their cooperating with us to provide the needed improvements to vertification. It is a measure of their sincerity. For us to back away from the standard of effective verification at this time would be a grave mistake when we are talking about—you are quite right—when we are talking about treaties where verification may be even more difficult such as in the area of strategic arms reductions.

If we cannot get the Soviets to move far enough to effectively verify the TTBT what does it say about the future of arms control?

Mr. LEACH. Let me then turn to the CTB issue. Many experts have testified that a comprehensive test ban may be easier to verify than threshold test ban because you no longer have this question of is it 30 percent off or 300 percent off. Would you agree with that?

Mr. BARKER. It is certainly easier above a certain detectability level to detect that something has happened than it is to detect its yield. I think that the high frequency technology that Dr. Kerr and Dr. Sykes have talked about offers great promise in reducing the level to which we can detect in a nuclear explosion. That technology is in its infancy; it is technology that needs further work. At this time I cannot comment on what level we can actually get down to because of classification concerns, but we are trying to drive that level down lower and lower with the verification research that is being conducted by the Department of Energy and the Department of Defense.

Mr. LEACH. Now, the Soviets have hinted largely that they may accept on-site inspection that you would say is the minimum level?

Mr. BARKER. Congressman, I think that is an issue that the political structure of this country has yet come to grips with. There is a very elegant article in "Science" by a seismologist from Livermore, Jim Hannon, in which he points out that as you go lower and lower in seismic magnitude, you find a larger and larger number of natural seismic events. Those events increase in number as you drive your threshold of detection closer and closer to zero. You come up with a large number of events that you cannot determine easily whether they are earthquakes or explosions. Many of them—all of them—could very well be earthquakes. When you get down into the subkiloton range, you are talking about several hundreds of ambiguous events per year.

Now, you can imagine—I am speaking as one who has been involved with the compliance work of the U.S. Government for the last 2 years—can you imagine a situation where we would be getting a signal once a day, every day of the year, that tells us a seismic event has occurred but we cannot tell whether the Soviets have violated the Comprehensive Test Ban Treaty or whether it is an earthquake?

Mr. LEACH. Let me suggest that this is not a new observation. It has been widely known for anyone that has followed the test ban for a long time. But if you draw the obvious conclusion from it, it suggests that we will never have a comprehensive test ban because of the difficulty in verifying explosions at that minimal level. Is that the conclusion you intend for us to draw?

Mr. BARKER. No; the conclusion that I would like you to draw from my testimony was the very carefully crafted statement that the administration has used for the last several years on the subject of a comprehensive test ban. And that is that a comprehensive test ban is a long-term goal for this administration in the context of substantial arms reductions. And in that context with regard to the phrase "long-term," mean within the 8 years of the Reagan term in office so that we will get it within the next 3 years, or are you saying long-term implies something stretched out into infinity?

Mr. LEACH. I certainly cannot predict the future beyond the next 3 years. I apologize for taking so much time.

Mr. BERMAN. Getting at what the gentleman from Iowa, Mr. Leach, asked initially. It would be interesting to read a State Department release of spring of 1983.

"Since 1976, questions have arisen whether the Soviets have exceeded the 150 kiloton threshold. Determining the yields of Soviet tests in difficult, particularly since the United States does not have the benefit of the data exchange and technical consultations provided under the terms of the treaties."

That is a State Department publication, and that puts a little bit of a different cast on this issue of the value of the data provided for in the Threshold Test Ban Treaty than the characterization that you gave.

Mr. BARKER. I agree that it does.

Chairman FASCELL. Mr. Solarz.

Mr. SOLARZ. Thank you very much, Mr. Chairman. This has really been a fascinating hearing, although a difficult one to fully understand.

I gather, Dr. Barker and Dr. Kerr, that if you felt that we could adequately verify the TTBT and the peaceful nuclear explosions treaty that you would then favor its ratification.

Mr. KERR. In that one, I am not an administration witness, but——

Mr. SOLARZ. You are entitled to an opinion.

Mr. KERR. Well, understood. My view is that the tactics by which the administration achieves some end with the Soviet Union is the administration's responsibility. I would urge, however, that first of all, if it were ratified that the data exchange be sought early on. And if enhanced verification were not part of the decision to ratify, it should be an option left open, based on what the quality of the data received is.

Mr. SOLARZ. My point is that your problems with these treaties is your concern over the degree to which we can adequately verify them.

Mr. Kerr. Yes.

Mr. Solarz. And if we could verify them, then you would be in favor of them.

Mr. Kerr. That's correct.

Mr. Solarz. OK. That's what I asked.

Mr. Sykes. We're speaking of comprehensive, aren't we?

Mr. Solarz. I was talking about those two for the moment. Now, this is a very serious question which we have to confront, and of course very difficult for us, because we're laymen. And that is whether or not it can be verified. Obviously it would be inappropriate and potentially counterproductive for us to ratify a treaty that we can't adquately verify. The scientific community appears to be divided. And we're laymen. So this creates problems. But, I'm going to see if I can try in layman's terms to get a better understanding of the differences between the two of you, I certainly am not one to trust the Russians and if our verification depended on trust, I would not find that acceptable.

Dr. Sykes said a little bit earlier, that he felt, if I understood him correctly, that we could given the year of Soviet tests, based on the seismological data we had within a range of 30 percent up or down of the actual yield. Do you more or less agree with that?

Mr. Barker. No, I think that in a sense of precision, based on seismological data, or seismic theory, that may be an accurate statement of the input of the seismic community to the process. What that leaves unaddressed, is determining the calibration—how you determine the center point of yield, of the estimated yield of a given event.

Mr. Solarz. Well, let me put it in a different way. Let's say there is a test of 150 kilotons, which I would say is true. They would abide by the treaty.

Given the verification procedures which exist, or would exist if these treaties were ratified, what do you believe is the upper limit of what the data on a test of 150 kilotons might suggest it would be; what would be the lowest limit?

If you use Dr. Sykes' 30-percent figure, when the maximum on 150 kiloton test will yield, a possible yield of 195 and the minimum would be 105. Under what you believe the upper and lower limits are, what would that be?

Mr. Barker. Congressman, I'm afraid, at the moment the Government handles the explicit answer to that question as classified.

Mr. Solarz. Is it substantially greater than Dr. Sykes' 30 percent?

Mr. Barker. You asked the number about the central point of yield, did you not?

Mr. Solarz. That's right. In a 150 kiloton test, he calculates the maximum possible yield based on the data we would have, would be 195 kilotons, which is 30 percent higher. There is a minimum of 105 kilotons.

Mr. Barker. I'm afraid I can't answer the question, but I want to introduce one other factor before we go on, and that is the fact that in conjunction with arriving at its conclusion regarding Soviet compliance with the TTBT, the Government has had to consider data other than seismic data in asking itself the question, how well calibrated are we?

Mr. SOLARZ. On seismic data, other than seismic data, do you mean immediate intelligence?

Mr. BARKER. I mean the totality of information available through all source intelligence questions, yes.

Mr. SOLARZ. You're talking about intelligence which we attained through national, technical means, scientific instrumentation and the like; or are you talking about, you know, intelligence from——

Mr. BARKER. The totality.

Mr. SOLARZ. OK, now I understand you correctly, the basic difference you have over verification is with respect to this question of determining with adequate precision what yield is of a seismic event. Is that correct?

Mr. BARKER. And determining the military and political significance of that uncertainty.

Mr. SOLARZ. And Dr. Sykes, you believe we now have the capacity to determine the yield within a range of 30 percent one way or the other?

Mr. SYKES. That's correct.

Mr. SOLARZ. OK, now is it your view, Dr. Sykes, that within that 30-percent range, which would give you a maximum yield of 195 kilotons, that a test of a 195-kiloton device would be or would not be of potential military significance to the Soviet Union? Would it be militarily significant, which would compromise our national interests, assuming we were testing a 195-kiloton device, as compared to a 150-kiloton device?

Mr. SYKES. Right. You would have to realize that I'm not a bomb designer. I'm impressed by previous arguments that have been put forth about factors of two times, three times, in other words explosions of 300 kilotons, 500 kilotons, in which people would say that would be of military significance, if they were testing there. I have not heard any presentations to the effect that 195 versus 150 would be significantly different.

Mr. SOLARZ. Dr. Barker and Dr. Kerr, assuming just for the purposes of discussion that Dr. Sykes is correct in saying that there is a 30-percent variance here, do you believe that a test at 195 kilotons in comparison to a test of a device with a yield of 150 kilotons would give the Soviet Union any potentially military significant advantages which we would not have if we would yield to the treaty and didn't test over 150 kilotons; and if so, could you, in lay terms, give us some sense of what those advantages might be?

Mr. KERR. Fortunately I don't have to deal with the "if so" because I don't think the difference between 195 and 150 would be militarily significant. The sort of thing that I think would be, is if the Soviet Union, for example, could test at a level like 300 kilotons. That is the factor of two that Dr. Sykes referred to.

Mr. SOLARZ. You think it would be militarily significant.

Mr. KERR. With a very small probability of detection, that would be militarily significant.

Mr. SOLARZ. I want to follow up on that in just a moment. But, can you explain in lay terms, Dr. Sykes, would you explain in lay terms why you believe we now have the seismological capacity to determine yield within a 30-percent range, and then Dr. Barker and Dr. Kerr, can you in lay terms tell us why you think Dr. Sykes doesn't know what he is talking about?

Mr. **Sykes.** Yes, over the past 7 years, the United States, particularly the Department of Defense, has had a very active research program in trying to use certain high frequency waves to see what is similar about various test sites in terms of the outer 100 miles of the Earth. There has also been extensive work on using longer period waves, or surface waves. I feel that we've reached a conclusion there, in which I indicate that it's around 30 percent.

Mr. **Solarz.** Does this reflect the yield of the majority of people in the seismological community?

Mr. **Sykes.** I think it certainly comes close to that. It's not everyone.

Mr. **Solarz.** Dr. Barker, who do you not accept that?

Mr. **Barker.** Well, let me correct the record of a moment ago and at the same time answer that question. Dr. Sykes, as he has noted, has served on various advisory panels in the area of seismology. To my knowledge, no committee on which he has served has made a recommendation that we have the ability to determine yields within 30 percent.

Mr. **Solarz.** What have we said?

Mr. **Barker.** That's the area where we are limited by classification concerns.

Mr. **Solarz.** Well, can you—are you just relying on the weight of authority? In lay terms, why would you regard the capacity to make such a fine judgment that we committed to about the yield to within 30 percent up or down of what the yield actually was.

Mr. **Barker.** When it comes to the area of seismology, the administration is dependent upon various panels and the institutions within the Government that contract work with seismologists. To my knowledge, those expert panels have not made recommendations consistent with Dr. Sykes assertion.

Mr. **Solarz.** Dr. Sykes, if you are right in saying that your views represent the clear rate of authority—not everybody, but almost everybody, why haven't they been reflected in the recommendations of these governmental panels?

Mr. **Sykes.** I think that that is happening, that there are two classified reports that have recently been submitted to two different parts of the Defense Department that do give some rather definitive information.

Mr. **Solarz.** Well, Dr. Barker, are you aware of these two reports that Dr. Sykes has related?

Mr. **Barker.** We are waiting for those reports to be evaluated by the organizations for whom they were performed, and we will combine the result with intelligent information to reevaluate our assessment of Soviet yields.

Mr. **Solarz.** OK. Dr. Kerr, you said that it would be militarily significant if the Soviet Union tested a device of 300 kilotons. Could you explain in lay terms what militarily significant advantages they might derive from such a test, assuming we have ourselves to testing 150 kilotons?

Mr. **Kerr.** Yes, as I explained——

Mr. **Solarz.** And that they would not be able to get from 150 kiloton tests.

Mr. **Kerr.** As I explained, opaquely in my remarks earlier, it's our belief that one can reasonably safely extrapolate in yield by about a factor of two. To that end, with 150 kiloton limitation, we look to something like 300. If you could test at 300, it would open a much higher yield range up that the United States would not be able to develop new weapons in.

Mr. SOLARZ. What kind of, if you tested at 300, what kind of weapons would they be able to devise or develop that they don't already have or that they already have, that would get the militarily significant capacities they don't already have. You know, I'm talking about warhead, not about launches or——

Mr. KERR. The point basically is if you open the yield range of 600 kilotons and above to the Soviet Union and you——

Mr. SOLARZ. How did you get to 600 kilotons?

Mr. KERR. If you could test at 300——

Mr. SOLARZ. No, you can't test at 300, you can test at 150.

Mr. KERR. All right.

Mr. SOLARZ. If you test——

Mr. KERR. You asked me if you could test at 300, what would that give you the capability of doing, I thought.

Mr. SOLARZ. Well, if you—you're talking now about a test at 600.

Mr. KERR. What I'm saying is a test at 300 could prove out certain designs that would function at a higher yield.

Mr. SOLARZ. In other words, you're saying if they tested at 300 and we'd say, "We invented a thing that shows; we've had a test between 150 and 600," and they would say "Well, it's obviously 150 but it really might be 600." So, what one could—Is that what you're saying?

Chairman FASCELL. Using the same differential as you do at the present limit of 150 if you applied it to 300,000, you would get to 600,000.

Mr. SOLARZ. That's exactly what I mean. And so he's saying that they could——

Mr. BERMAN. No, he's saying that the weapon tested at 300 would now allow you to construct and build a weapon that would be at 600.

Mr. KERR. Let me say it a little differently so that hopefully there won't be as much confusion. It is possible with certain classes of designs to test at less than full yield, yet retain substantial confidence at that full yield. For example, using a factor of two, one could test at 150 kilotons, a design which when fully weaponized might be at 300.

Mr. SOLARZ. OK, so you could then test at 300——

Mr. KERR. And allow 300, you can go even farther beyond 600, because of some peculiarities.

Mr. SOLARZ. OK. Let me just rephrase my question then. What can they test at 300 that would give them militarily significant capacities that they don't already have? And can you, in lay terms, indicate what—In other words, right now, I look at it as a layman. I know that they can blow up Washington. They can blow up New York. I know they're of the kind of pinpoint accuracy that enable them to knock out our land, our Minuteman freeze. I know that they can hit command and control points. It's—I know they can do all that. I know what the SS-20's can do. I want to know what they would be able to do if peculiarily militarily, if they tested at 300 kilotons?

Mr. KERR. At the risk of sounding disrespectful, I'll give an example. Let's assume the Politburo said that they had to limit the range of their missile to 10,000 kilograms. They then might be able to develop a highly mobile survivable single-warhead missile with a megaton yield.

Mr. SOLARZ. I'm afraid at the risk of sounding unintelligent, I will ask you to repeat that answer.

Mr. KERR. What I'm doing is translating the Midgetman with the congressionally imposed restriction on the weight of the delivery system, which means that if you had to use existing warheads, it would be very difficult to do it and have the military capability you want and at the same time honor the congressional stricture on the weight of the missile. If they operated under similar constraints——

Mr. SOLARZ. But they don't have similar constraints.

Mr. KERR. I don't know what they have. No; what I'm trying to point out is that they could develop new capabilities, like a high-yield, mobile, relatively lightweight system that would enhance survivability and could do that in a manner that we could not.

Mr. SOLARZ. What if they do, conceptually? Because it strikes me that if they do that, that's not necessarily so bad.

Mr. KERR. No; that's a matter of judgment on that.

Mr. SOLARZ. I mean if the only militarily significant thing they could do would be to develop a high-yield, light, mobile missile, which would enhance the survivability of their forces, because it would locate impossible thrusts, the launch of first strike against them, I think many theoreticians would say that that's not an unhelpful develoment, because it's important for them to have confidence that we can't launch a first strike against them, so that they don't have the temptation to go for broke against us just as we need the confidence that they can't launch such a strike against us.

Mr. BARKER. Would you deny us the same ability? The ability to develop a megaton warhead for lightweight——

Mr. SOLARZ. I'll tell you one thing, Mr. Barker, we should have never forced them into a mobile system.

VOICE. Well, why else would they want to develop that 300 kilotons besides this——

Mr. KERR. As you are aware, the real questions of military effectiveness don't simply address yield. It's the combinaton of yield and accuracy. The sorts of things they might choose to do could be everything from long-range cruise missiles to standoff missiles for aircraft, to the sort of thing that I mentioned.

Mr. SOLARZ. You think that they would not be able to do if they limited it to the——

Mr. KERR. The simple point is they could work on both points of the equation—accuracy and yield. While, if the 150-kiloton limitation applied to us, we basically could only work on one part, accuracy.

Mr. SOLARZ. No, that I understand. But, whether they work on accuracy and yield combined gives them the capacity to do what they don't already have. You mentioned one thing, develop a mobile missile with a light, mobile missile. What else? Is there anything else you can think of?

Mr. Barker. Congressman, might I suggest a modification of the question that might make it easier for Dr. Kerr to answer. What I think is of importance here, is the asymetry that may result between the United States and the Soviet Union. This point would be addressed if you could rephrase the question in the form of "What is it that the Soviets could do that we could not do?"

Mr. Solarz. That is in essense what I tend to point out. Now, I yield to the gentleman from California for just a second. But, we similated in that fashion, what in military terms, what kind of weapon systems could the Soviets then develop which they don't have now, which we would be unable to develop, which we don't already have?

Mr. Kerr. They would be able to further develop systems that would be seen increasingly as hard-target capable, because of the greater yield/accuracy combination available to them and not apparently to us.

Mr. Solarz. But don't they have, so far as I can determine, for anything that the administration says, they already have a sufficient number of hard target, capable missiles sufficient to destroy all of our land-based ICBM's and out 10 commanding control posts?

Mr. Kerr. If I understood the Soviet force structure and why they build the numbers and the character of systems that they do, I would feel very different about things than I do today, when faced with uncertainty. We don't know why they build the forces they do and deploy the forces they do in the numbers they do. So, I can't answer that question.

Mr. Solarz. Dr. Sykes, let's assume you're wrong for a minute about the 30 percent, and let's assume it's in the 2-to-1 range, that was the figure Dr. Kerr used. Do you have any judgment about the extent to which, if the verification perimeters are within the 2-to-1 range, of the degree to which they could, in fact, then potentially develop weapon systems which we would be precluded from developing, which would give them militarily significant advantage?

Mr. Sykes. No, I really don't have an opinion on that because I'm not a weapons designer.

Mr. Solarz. Right.

Mr. Sykes. The work that I have done on going back to the period before the Threshhold Treaty went into effect in 1976, indicates that the Soviets—their very largest tests were around 500.

Mr. Solarz. Let me ask you this. About the one key difference between the two of them, you think there is a 30-percent perimeter with respect to verification of yields. They say it's considerably higher, but concede that if it was 30 percent, they would agree that nothing militarily significant can be done within that 30-percent perimeter.

Mr. Barker. I didn't go quite that far.

Mr. Solarz. What did you say? I thought in effect you said—maybe Dr. Kerr did. Do you disagree? Do you think that a 30-percent perimeter——

Mr. Barker. I did not comment.

Mr. Solarz. Well, can you comment? Will you comment?

Mr. Barker. No.

Mr. Solarz. Why not?

Mr. **Barker**. If the administration came to believe that the uncertainty was 30 percent, we would have to readdress the issue and reassess our opinion as to whether the TTBT could be effectively verified.

Mr. **Solarz**. But, Dr. Kerr, your opinion was that if it is within 30 percent, then it would not be militarily significant.

Mr. **Kerr**. Yes, that's my view.

Mr. **Solarz**. Right. And you are deep into the area of weapons design and development. That's what you folks do out there, right? OK.

Mr. **Kerr**. Yes, we do.

Mr. **Solarz**. OK. Now, Dr. Sykes, you just—two more questions, Mr. Chairman. Dr. Sykes, do you have any and maybe Dr. Barker, you could—you know this confronts us with a very serious dilemma. I mean, you know, certain political and substantive attractions to this resolution, the military responsibilities to this country. I certainly don't want to advocate a course of action which could potentially compromise the national interest. We have a division of opinion in the scientific community here. But ipso facto that division is not an argument against it, because they never had any treaty, because there's always some difference of opinion. If you were us, as lay people, how would you approach the problem of trying to determine where the truth lays in this dispute, particularly with respect to the 30-percent figure, which I see it as a key difference between. You are saying that we can do over 30 percent. They say we can't.

Mr. **Sykes**. Yes, for example, we do have—in fact there was a letter to the chairman from a prominent scientist, Hannon at the Livermore Laboratory in which he did some assessments as to whether the Soviets are cheating on the 150 kiloton limit. And he has a statement there. So, at least on that question of whether a factor of two is the appropriate number, or 30 percent. That's something from my expertise, I feel quite qualified to give you an opinion.

Mr. **Solarz**. Right. Do you feel your expertise is superior to their expertise?

Mr. **Sykes**. For example, I tried to quote another of the weapons laboratories.

Mr. **Solarz**. Right.

Mr. **Sykes**. In that case, the Lawrence Livermore Lab has about 12 prominent seismologists working on this problem. That is one area in which Los Alamos, even though they have great expertise in the design of weapons is not strong——

Mr. **Solarz**. Do you think that the Livermore people would agree with your 30-percent judgment?

Mr. **Sykes**. I think generally so. But the letter does not give an exact number.

Mr. **Solarz**. My last question is, I gather, Dr. Barker, do you feel testing of our weapons is necessary to maintain the reliability of our nuclear forces? Do you testify to that effect?

Mr. **Barker**. Yes.

Mr. **Solarz**. Right. If that is the case, why do you say that an objective of the administration is a comprehensive test ban treaty, since a comprehensive test ban treaty would presumably preclude testing?

Mr. BARKER. It's a goal to be pursued in conjunction with trying to reduce the reasons which require nuclear testing today—for reasons of stockpile reliability among others.

Mr. SOLARZ. Can you envision circumstances under which stockpile reliability can be assured without testing?

Mr. BARKER. I believe that the history of the nuclear weapons laboratories has shown an improvement in the understanding of their science. It is not beyond my ken that we could arrive at a day in which the directors of the weapons laboratories would assure the President of the United States that they could continue to certify to the reliability of the nuclear arsenal in the face of a comprehensive test ban. But until that day arrives, I personally believe that the risks associated with a comprehensive test ban are not commensurate with——

Mr. SOLARZ. And again, Dr. Sykes, it's your judgment that testing is not necessary to assure the reliability of the stockpile, or do you believe testing under existing circumstances is necessary?

Mr. SYKES. Well, again, there, that's a question that is one in which I'm not a weapons designer, but for example, there was a very prominent letter written to President Carter from three physicists who have been prominent in this program, in which they stated that it would be possible to rely upon weapons into the future if certain steps are taken.

Chairman FASCELL. That material, I might add is in the record.

Mr. SOLARZ. Mr. Chairman, it is Mr. Dornan who's been indulgent.

Mr. BARKER. Could I be indulged one moment? Congressman Solarz asked a question that I didn't get an opportunity to answer and that was, what advice could I provide with respect to what the Congress should do in view of the diversity of the views and the technical information with which it is presented? I think we all often find ourselves in a situation where we are presented with experts with divergent views in areas we don't ourselves understand. My own approach, where I find strong differences of opinion on two sides is to conclude that the truth probably can't be pinned down. An objective person can not differentiate between those two opinions. One can't estimate where the truth lies between those two views. I believe that one must take a very conservative view, where national security is concerned. I believe one must take that approach which is most consistent with the security of this country. In this regard, I would invite the Congress, for the security of this country to join the President in encouraging the Soviets to be responsive to the initiatives on our part to improve the verification capabilities.

Mr. SOLARZ. Well, although I gather that to violate this treaty in a militarily significant way, you'd have to have a whole series of tests. It couldn't be just one or two.

Mr. KERR. That, in fact, is incorrect. Normally, even in the development of a high-yield system, most of the tests are conducted at rather low levels and only one or two are needed to certify the full yield performance. And so there is an issue both of yield and number here. And a small number tied into a development program could make a difference.

Chairman FASCELL. Mr. Dornan.

Mr. DORNAN. Mr. Chairman, you have run our major committee as fairly, I think, as Clem Zablocki did and I think that's really saying something. And I appreciate that you are doing that also with this subcommittee. Myself excluded, I'll leave others to judge this, but there's something about Foreign Affairs Committee that very thoughtful members in both our parties gravitate toward this committee, and I think some of those very same thoughtful members have gravitated toward this Arms Control Subcommittee. I supported, without any imput, your adding those two words arms control in the front of the title of one of our most important subcommittees. What I would like to do now, because our staff on the minority side has worked so hard on this issue and questions relating to this, is submit several questions for written answers. You could certainly do this on the majority side where work product is just as effective with many more dedicated people. I would like to submit for all three of these fine gentlemen, the 29 quesions of the minority side.[1] When it comes time for my 5 minutes, I can't possibly go through 29 superb questions. I've been trying to figure out, out of all of these excellent questions, which one to select for my 5 minutes. So if I could ask our minority staff to provide two more copies for Dr. Barker and Dr. Sykes, I'll give my copy to Mr. Kerr. I know that you don't have as much staff assistance as Dr. Barker, and we're trying to increase his staff here with lots of deficit dollars that we don't have. But, it's because the subject is so important. That's one: No. 2 is, I would like to, with what remains of my time, go down the line and ask each one of you to relieve some of your frustrations. As thoughtful as I think all of my colleagues are on both sides of the subcommittee, remember we are pulled in a 100 different directions by as many nations as there are in and out of the U.N., 159 plus 16 or so others, and by a thousand other issues with all of our Committee of the whole work that comes up on the House floor. What would you recommend, to recommend to us in Congress, that we do—I've been out to Los Alamos, Dr. Kerr, in 1978, and I've never forgotten the few things that I learned there when exposured to that free world treasure. What should we do to become better informed? Should we come to your site for more discussions on this? I think in the popular culture, Dr. Syke's viewpoints get more attention than yours. It certainly does in the three major newspapers in this country, and with the three networks. I don't think anybody has all the answers to this arm control nightmare because I've never seen such graciousness on the majority side, by admitting that they're reaching for answers and solutions to all of the problems that we on this subcommittee generate. Just one at a time, gentlemen, tell me, a couple of minutes each, what you would recommend we do as laymen to test our beliefs and suppositions. Dr. Kerr?

Mr. KERR. Well, I think one point that has become very clear—the three of us represent a broad spectrum of views and capability.

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[1] Responses appear in app. 67

We aren't the only people involved in reaching conclusions about verification. And so I think a great aid to your deliberations would be to have an improved cross section that could take us some of these issues of interpretation that I was referring to earlier. There is this question of the seismic data and its nature. As Dr. Barker pointed out, there's other information from time to time available, and I think it would be very useful to understand how that fits together. Second, while I tried in this setting to give some indication of the role that testing plays in weapons development, the murky answer that I gave to Mr. Solarz about the advantages of the higher yield opportunity being available was necessarily constrained in this setting.

And whether it was your desire to have a closed hearing, or to visit a facility like my laboratory or the Livermore Laboratory would not matter, but those things could be discussed with you in greater depth so that you would understand it in the sense of what leverage you get out of the availability of higher yield testing opportunities.

So, those two points from my point of view would assist you and perhaps make this general deep policy questions an easier one to grapple with in the future.

Mr. DORNAN. Thank you for your answer. Mr. Barker. Any other frustrations that you may have come across your mind while testifying.

Mr. BARKER. Well, I want to thank you for the opportunity, but I also want to thank the committee as a whole, because I think we really have covered the waterfront on this issue but, as Dr. Kerr said, in some cases, I think the ability to have had a closed hearing might have better illuminated some of the issues that we have touched upon.

I would recommend to all of you the President's Compliance Reports for 1984 and 1985, which do add some vital information on this particular subject as well as addressing the other areas of Soviet noncompliance with their arms control agreements. To make a final statement, I think that if arms control is to succeed, there are a lot of preconditions to be achieved if we are going to come up with significant agreements. Clearly the Soviets are going to have to take arms control more seriously than they have. But also, I think the Soviets have to perceive the U.S. Government as being serious and committed to a long-term philosophy as far as arms control is concerned. It does disturb me personally to see what the Soviets must perceive as differences of opinion, differences of objective between the administration and the Congress in this regard. And House Joint Resolution 3, unfortunately seems to do that. At least it is my personal perception that it does. I think the administration has made a reasonable request of the Soviet Union. I've said this so many times that maybe you're bored with it. But that reasonable request is to come up with a reasonable, technical basis for verifying the threshold treaty. It would be a significant contribution if the Congress were to endorse that request, encourage the Soviets to join with us in improving verification provisions.

Mr. BARKER. The Soviets have not yet agreed to even meet and discuss the issue with us. Maybe they will take us more seriously if they see the Congress also supports the administration in that regard. It's not a guarantee, but it's a hope.

Chairman FASCELL. That's why there is language in House Joint Resolution 3 on the subject of verification.

Mr. DORNAN. Mr. Barker, this is already a negotiated treaty, a great deal of what we have been discussing here.

Mr. BARKER. Correct.

Mr. DORNAN. But they're saying, "We're not going to do this any more because there is a negotiated treaty on the desk. Do something with it."

Mr. BARKER. And we have told them, that as negotiated, it is not effectively verifiable. We have offered to speak with them, be it a side agreement, be it a change in the treaty, be it an Executive agreement, some mechanism by which the United States can be assured that the treaty will be effectively verifiable.

Mr. DORNAN. Because it's been dead in the water all the way back to President Carter's tenure.

Mr. BARKER. Yes.

[Simultaneous discussion.]

Mr. BERMAN. Will you yield your time——

Mr. DORNAN. Yes; certainly. I yield to the gentleman.

Mr. BERMAN. Just in line with that, I don't—I'm left with the combination of your answers to Mr. Dornan and to Mr. Solarz with the impression that there is this treaty that we haven't ratified, but we are nonetheless complying with, that allows the Soviet Union to test a smaller-sized missile and warhead and achieve goals of both accuracy and—what was the other word you used?

Mr. DORNAN. Yield.

Mr. BERMAN. Yield—while we are limited to only going for accuracy. And, based on the scenario that you painted we're sitting here, willy-nilly going along while right now they can be testing this kind of a thing, which apparently would put us at a disadvantage. I guess, if it's alarming enough for you to mention as a possibility, it's alarming enough to affect our national security. I can't believe that's happening. The scenario that you paint about what's militarily relevant confuses me, because we're complying with this treaty right now. Why are we giving up on testing for yield and letting the Soviet Union do it, as we develop our smaller missiles?

Mr. KERR. Well, I'm sorry. I answered the question, what would be possible for the Soviet Union if they could test at 300 kilotons and not be detected, in violation of the 150——

Mr. BERMAN. But before that you said——

Mr. KERR [continuing]. What military significance might that have?

Mr. BERMAN. But before you——

Mr. KERR. What asymmetry might result?

Mr. BERMAN. But I thought before that you said that the Soviet Union could test at twice the 150 without being detected; in contrast to Dr. Sykes position, they could test at 30 percent higher than the 150.

Mr. KERR. No, there was an "if" in front of that.

I didn't say they could, because that was not the way the question was asked.

The question was asked if they could, without risk, test at a higher yield what military significance would that have.

And that was the question I answered.

Mr. BERMAN. Well, then, let's deal with the "if."

Chairman FASCELL. This resolution, I might add—if the gentleman from California will yield at this point——

Mr. BERMAN. Sure.

Chairman FASCELL [continuing]. Does not mandate anything to the President; it simply says that the President should request the advice and consent of the Senate to the ratification of the two testing treaties.

And it has a very important addendum: The resolution provides that the President submit a report to the Congress containing any plans the President may have to negotiate supplemental verification procedures or, if the President believes it's necessary, any understanding or reservation on the subject of verification.

Now, I don't know why that doesn't leave ample room to address the issue.

Mr. BARKER. There are two aspects of concern associated with that.

One is the fact that I find nothing in the history of Soviet-United States relations that would lead me to believe that the Soviets would accept U.S.-dictated verification provisions to a treaty.

We have had a difficult enough time mutually arriving at——

Chairman FASCELL. We said "negotiate"; we didn't say "impose."

Mr. BARKER. Well, maybe you and I are just reading the resolution differently then, Mr. Chairman.

My understanding is that what the administration has been asked to do is to submit, at the time of the request for advice and consent, a statement which would basically dictate to the Soviets what kind of verification provision we require to be added to that treaty.

Chairman FASCELL. No. The resolution is clear: It states that we negotiate supplemental verification procedures.

Mr. BARKER. And what we are attempting to do, Mr. Chairman, is to convince the Soviets to negotiate before we submit that document to the Senate. That's the difference.

Mr. DORNAN. Mr. Chairman.

Mr. BARKER. And we would like the Congress to join us.

Chairman FASCELL. Well, let me see if Mr. Dornan is finished.

Mr. DORNAN. Well, Mr. Chairman, I just wanted to be fair to Dr. Sykes and tell him that if he felt a little uncomfortable on a panel of three, with two of a much different viewpoint, we, on the minority side, are used to having panels structured the opposite way. But then there are just barely 42 percent of us to 58 percent of them. So, it's always the other way around.

I gave up a "Victory in Europe" 40th anniversary parade and celebration over at Fort Myer this afternoon gladly because my liberal friends tell me that if there's ever another victory day, the survivors will envy the dead and will be celebrating only as they choke to death under the darkened skies of a nuclear winter. And I tend to believe that that is probably true.

What do you think we can do, as laymen, as Mr. Solarz said, to pursue diligently this issue with fairness to all viewpoints and any other frustrations you felt this afternoon in an excellent discussion?

Mr. SYKES. Well, perhaps one of the frustrations that I felt was that there was not a counterpart of Dr. Kerr here who could answer the questions on weapons design and that I had to admit that, you know, I am not an expert in that area.

So, I would certainly like to see that side addressed from someone that has a serious, but different, point of view. Perhaps, again, a closed hearing could go into some of the classified data released to the question of uncertainty.

Perhaps, again, thinking about this question that was brought up, the factor of "2" uncertainty—and even though the letter from Dr. Hannon of the Livermore Lab did—he was not asked the question "Is the uncertainty 30 percent, or what is it?"—I don't think that he would have made the statements that he did if the uncertainty was, in fact, a factor of "2"—like we had discussion here.

Chairman FASCELL. Dr. Barker, why wouldn't it be sufficient just simply to have a reservation on verification? Since we're complying with the treaty anyway, why wouldn't we submit it for ratification with a reservation on verification and take the political advantage?

You're not giving up anything militarily then; that's for sure.

Mr. BARKER. The advice upon which we are depending is obviously different. The advice that I have——

Chairman FASCELL. I understand. In other words, it's a political decision.

Mr. BARKER. It's a political decision, and I think it's also a matter of principle. As a matter of principle, before we submit any treaty to the Senate, seeking its advice and consent, we would like to be sure that that agreement is in the national security interests of this country and therefore is effectively verifiable.

We've established for ourselves that hierarchy; you are suggesting another.

Chairman FASCELL. Yes, I understand.

Mr. SOLARZ. Mr. Chairman.

Chairman FASCELL. Mr. Solarz.

Mr. SOLARZ. Yes; Dr. Sykes, is your confidence in verification, if these treaties were ratified, depend on the submission of data to us by the Soviet Union for which we have better means of independently confirming the accuracy of?

Mr. SYKES. No; this number that I gave you, of 30 percent, assumes that we not have any other data.

Mr. SOLARZ. But you pointed out that—if I recall correctly, that these treaties do require the Soviets to give us some data?

Mr. SYKES. That's right.

And I think, unlike the other statements that you've heard, I believe that that data package will be helpful.

Mr. SOLARZ. And what is that data package?

Mr. SYKES. Well—and particularly, I deal with the one type of data that will be very valuable, and that's the information on the geological properties of the test sites.

Mr. SOLARZ. And is——

Mr. SYKES. We're not being asked to completely buy—just——

Mr. SOLARZ. Can——

Mr. SYKES. Sorry.

Mr. Solarz. Is there a way for us to verify the accuracy of the data the Soviets would give us with respect to the geology of their test sites?

Mr. Sykes. For example, we already have quite a bit of information about the geology of the main Soviet test sites. So, it's not as if we're in a situation of knowing nothing and we're asked to buy a complete package.

Mr. Solarz. But do you think the additional information would be helpful?

Mr. Sykes. I believe that it will be helpful.

Mr. Solarz. But how do you know the Soviets won't distort the additional—could they distort the additional information?

Mr. Sykes. I think that in that particular area it would be exceedingly difficult, because we have a variety of data from satellite photography. We are likely to have some data that they're not sure or don't know that we have.

Mr. Solarz. Dr. Barker, do you have a response to that?

Mr. Barker. I believe there are qualified geologists and other experts who have a different view of the matter than that of Dr. Sykes.

Mr. Solarz. Which is what?

Mr. Barker. Which is that the kind of information which would be available to us as a result of the data exchange could be constructed in a misleading manner.

Mr. Solarz. With respect to the geology of the testing sites in particular?

Mr. Barker. Yes.

Mr. Solarz. But could be constructed in a manner which would be misleading but which we would not have the capacity to determine was misleading?

Mr. Barker. I think we would be very hard pressed to prove that the data was wrong. And what would happen would be just a further continuation of the environment we now find ourselves in—some people believing that we have been misled and other people asserting that the data is perfectly good.

Mr. Solarz. OK.

And, Dr. Sykes, how would you respond to the point that they would have the capacity to provide us with data which was misleading, but which we, based on the information we already have, couldn't be sure was misleading and therefore, in a certain sense, we would be relying on the information they gave us without the capacity to adequately, independently confirm it?

Mr. Sykes. All right. I say we already know quite a bit of information——

Mr. Solarz. Oh, quite a bit.

Mr. Sykes [continuing]. About geology.

Mr. Solarz. About everything.

Mr. Sykes. We don't know everything, but we have a number of crosschecks that can be made there.

Mr. Solarz. But is it possible for them to give us information that was inaccurate where we would not know it was inaccurate?

Mr. Sykes. That might be in one or two tiny details. But I think in terms of an overall package, it would be exceedingly difficult to make it entirely erroneous.

Chairman Fascell. Thank you, gentlemen.

Any other questions?

[No response.]

Chairman Fascell. Gentlemen, thank you very much.

We appreciate your responses to Mr. Dornan's additional questions, and we'll hold the record open until we receive your answers.

We also appreciate your time and your interest and your willingness to subject yourself to this continuous barrage of questioning. Thank you.

Chairman Fascell (to the members). You have House Joint Resolution 3 before you. I do not know of any difficulty with respect to the whereas clauses. So that leaves the resolve clauses on pages 2 and 3. The only comment I have with respect to those resolve clauses is to note that they are not expressing a mandate. They indicate that at the earliest possible date the President of the United States should request the advice and consent of the Senate to the ratification of the testing treaties, with the proviso that any information with respect to negotiating supplemental verification would be submitted at the time the President seeks ratification if he deems it advisable. In other words, if the President believes it is necessary, he can include his reservations on the subject of verification as part of the ratification process.

So the way I see it, we are faced primarily with a political decision with respect to proceeding. And the second part of this is that the President should propose to the Soviet Union the resumption of negotiations toward a verifiable Comprehensive Test Ban Treaty, with the additional proviso, of course, that the United States is not bound to any bilateral arms control agreements with the Soviet Union that the Soviet Union is violating.

So it sounds, at least, as if there are sufficient safeguards, even in light of the question that have been raised and so ably presented.

My thought would be that we would take this resolution to the full committee and continue this discussion.

Voice. I move the approval of the resolution, Mr. Chairman.

Chairman Fascell. Mr. Solarz.

Mr. Solarz. I just want to say, I may—I would like to reserve the right to offer an amendment when we reach the full committee.

Chairman Fascell. Well, everybody has that right.

Mr. Solarz. Yes.

Chairman Fascell. Everybody will have that right, and, of course, you are protected both ways.

Mr. Solarz. I essentially am sympathetic to the thrust of the resolution made by Mr. Hyde.

Bells went off when I heard my friend from Illinois refer to this as act off freeze, or the freeze revisited. He had some colorful characterization for the resolution. And I recall the 40 hours we spent on the floor debating the freeze resolution. It was not the most inspiring or illuminating moments of my own service in the House, although it may have been the most laborious.

And I do think that if we are going to report this out of the full committee that there ought to be a very thorough airing of this when we reach the full committee, and to the extent possible the concerns, some of which were expressed today by our witnesses, some of which were alluded to by some of the members of the committee, and to the extent that those concerns can be dealt with in the text of the resolution, I think it would make it a more constructive one.

And I can think of one or two. This is not the time, perhaps, to deal with them, but I would hope before the process is over, that if some of these concerns can be accommodated in the text of the resolution without depriving the resolution of the essential thrust of what it is trying to accomplish, that that would be useful.

Mr. HYDE. Mr. Chairman, if I may comment?

Chairman FASCELL. Mr. Hyde.

Mr. HYDE. I see some serious problems with House Resolution—House Joint Resolution 3 in the context of our ongoing disarmament talks in Geneva. We are segregating out, it seems to me, a very important element. That is that we should propose the immediate resumption of negotiations toward a verifiable comprehensive test ban treaty. Let us assume it is verifiable. If we were to stop all testing, that locks us in to a rigid ban—no further testing.

As for the administration's position, it is that we should work toward that end in the context of substantial nuclear force reductions. And whether or not this undercuts or removes the incentives that the Soviets would have for reducing, inasmuch as they know we are not going to test anymore, it has to be discussed extensively.

Chairman FASCELL. Will the gentleman yield right there?

Mr. HYDE. Yes.

Chairman FASCELL. It is a good point. But the treaty has to be negotiated, Henry.

Mr. HYDE. I understand that, but you negotiate within the larger context, it seems to me, of reductions. If this is—if I were the Soviet Union, I would like to lock us into a comprehensive test ban, because they got theirs, and we are barely on the threshold of MX. And so the asymmetry, it seems to me, is something that cannot be considered in isolation away from the comprehensive talks that are going on, hopefully toward reduction.

You have got SDI. This is just reaching in and pulling the raisins out of the cake and saying, here, comprehensive test ban treaty, see what we have done.

But how does that relate to reductions, how does that relate to the whole problem. And I really have misgivings about isolating a comprehensive test ban treaty which, in my opinion, disadvantages us because we have not got a modern nuclear land-based leg as compared to the Soviets.

Maybe that is a good idea, but I would rather do it in a mode where we have all reduced these damn things, and then ban the future development of them. But just to do this alone I think is dangerous.

Now, I am not saying we should—we have got to throw this to the full committee, this is too important, and, you know, it is a politically, you know, sexy thing. But, damn it, I just think, as Steve Solarz said, unless this could be put within the framework of reducing nuclear weapons, which is what we are in, and this does not undercut that effort, that would be my understanding.

Chairman FASCELL. Well, let me just suggest a possibility here, and I am not hung up on it one way or the other.

We are in the throes of comprehensive discussions now. There is no reason why we cannot make it more comprehensive.

Mr. HYDE. Well, I would like to hear Max Kampelman or somebody like that comment on this resolution and how it would impact on what they are doing.

I am just suggesting this is controversial, and I guess it should go to the committee, and I am not objecting to that. I am just telling you that——

Chairman FASCELL. OK.

Mr. HYDE [continuing]. There is going to be a battle on this.

Chairman FASCELL. Well, let us see what we can do when we get to the full committee. I think the points are well made.

All those in favor of reporting this to the full committee signify by saying "aye."

[Chorus of "ayes."]

Chairman FASCELL. All those opposed, "no."

[No response.]

Chairman FASCELL. The "ayes" have it, and so the resolution is approved for full committee action.

[Whereupon, the subcommittee proceeded to other business.]

PROPOSALS TO BAN NUCLEAR TESTING

TUESDAY, MAY 14, 1985

House of Representatives,
Committee on Foreign Affairs,
Washington, DC.

The committee met in open markup session at 9:55 a.m., in room 2157, Rayburn House Office Building, Hon, Dante B. Fascell (chairman) presiding.

Chairman Fascell. The committee will be in order.

We have some colleagues who are in the caucus. We have others who are at a leadership meeting at the White House. They will be along soon.

We have several pieces of legislation on the desk before you. The arms control and disarmament and agency authorization bill, the comprehensive nuclear explosive testing bill, a resolution on the Micronesian Compact of Free Association, and one on genocide, and one on the Prime Minister of India's visit. Three of these are candidates for suspension, so we will undertake to consider those first.

[Whereupon the committee proceeded to other business.]

Chairman Fascell. The next order of business is House Joint Resolution 3, dealing with limiting nuclear weapons testing and urging the President to request ratification of the Threshold Test Ban Treaty and the Proliferation Treaty and to resume negotiations on a comprehensive test ban.

Mr. Gilman. Mr. Chairman, point of inquiry. Some of our members who have been vitally concerned with this measure are unavoidably absent: one is in markup and the other gentleman is in the White House at the present time. I would like to make a request of the committee, if it would be possible, to put the deliberations of this measure over to a later date or at least the final determination by the committee to a later date when these members would be available. It is an important measure. It has a great deal of impact upon our foreign policy. I would welcome if some consideration could be given to those members who are unavoidably absent this morning because of their commitments in other areas.

Chairman Fascell. I will say to the gentleman, we do have some on your side at the White House this morning. I know the ranking minority member is there.

Mr. Gilman. Also, several of our senior members are there.

Chairman Fascell. I was supposed to be there and didn't go, also.

I think that we will have to delay consideration of this matter until such time as we get some of those members back.

Mr. SOLARZ. Mr. Chairman, if you are going to delay consideration of House Joint Resolution 3, I gather the Compact of Free Association with Micronesia would be next on the agenda. Would it be possible to ask for a recess of about 15 minutes before we take that up?

Chairman FASCELL. Absolutely.

Mr. SOLARZ. Or maybe until 10:30 a.m.

Chairman FASCELL. At least until 10:30 because the members who are at the White House probably start back around that time and should be here by 11 a.m.

We will temporarily defer consideration of House Joint Resolution 3 and take an informal recess now.

Mr. Leach.

Mr. LEACH. I certainly appreciate the Chair's willingness to defer to some of our Republican colleagues' conflicts. But if that is the case and we are going to defer consideration of the Micronesian Compact, maybe we can at the same time defer consideration of House Joint Resolution 3 but not put it off to another day.

Chairman FASCELL. Well, we are not——

Mr. LEACH. So we are just putting it off until later in the day today?

Chairman FASCELL. We are informally recessing now to give some of the members a chance to get back from the White House.

Mr. LEACH. Fair enough. So the thought isn't that we will defer to another day, but that we will just later in the day look at House Joint Resolution 3?

Chairman FASCELL. We will be able to continue with this.

Mr. LEACH. Good.

Chairman FASCELL. That is my idea.

In the meantime, it will give the people who are working on the Micronesia Compact a chance to get together.

Mr. SOLARZ. Mr. Chairman, what time then would you plan to call the committee back into session?

Chairman FASCELL. Why don't we say in 30 minutes.

[Recess.]

[Whereupon the committee proceeded into consideration of other business.]

PROPOSALS TO BAN NUCLEAR TESTING

WEDNESDAY, MAY 15, 1985

House of Representatives,
Committee on Foreign Affairs,
Washington, DC.

The committee met in open markup session, at 10:32 a.m., in room 2172, Rayburn House Office Building, Hon. Dante B. Fascell (chairman) presiding.

Chairman **Fascell**. The committee will come to order for the further consideration of House Joint Resolution 187, the Micronesian Compact of Free Association and House Joint Resolution 3.

[Whereupon, the committee proceeded to other business.]

Chairman **Fascell**. The next order of business is House Joint Resolution 3, which is before you, dealing with limiting nuclear weapons testing. And the chief of staff will read the resolution.

Mr. **Brady** [reading]:

> H.J. Res. 3, Joint Resolution to prevent nuclear explosive testing.
> Whereas the United States is committed in the——

Chairman **Fascell**. Without objection, further reading of the resolution will be dispensed with; it will be printed in the record [1] and is open for amendment at any point.

The Chair recognizes himself for beginning the discussion on this resolution.

This resolution urges the President to request ratification of the Threshold Test Ban Treaty negotiated under the Nixon administration and the Peaceful Nuclear Explosions Treaty negotiated under the Ford administration and to resume negotiations on a verifiable comprehensive test ban treaty—and the resolution also calls upon the President to include any reservations on verification that he would want to attach to the two treaties, if any.

The same language of House Joint Resolution 3 passed the Senate last year by a vote in excess of the two-thirds necessary for treaty ratification. That vote was 77 to 22.

So, basically, the language speaks more or less for itself, in the "Resolved" clause, "That at the earliest possible date, the President of the United States should—(1) request the advice and consent of the Senate to ratification" of the two treaties, one signed in 1974, one signed in 1976.

And then, if you look at the parenthetical language of the resolution, it states: "[with a report containing any plans the President may have to negotiate supplemental verification procedures, or if the President believes it necessary, any understanding or reservation on the subject of verification which should be attached to the treaty]"—and that's because of the obvious debate that's going on with respect to verfication. But obviously, all of us are interested in verification, and this would give the President the flexibility to make whatever reservation he deems advisable.

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[1] See app. 1.

The second part of the "Resolved" clause states that the President should "propose to the Soviet Union the immediate resumption of negotiations toward conclusion of a verifiable comprehensive test ban treaty," which has been an objective of virtually every administration, including this one.

So basically, we're going on record with what has been the policy of this country now for a long time. The question is: Why the resolution?

The answer is basically that for some 3 years now the administration has been telling us that they have been reviewing these treaties and that as soon as they finish their review, they would make up their minds as to whether or not they wanted to submit them for ratification.

Technically, the treaties are in the Senate. So, what the resolution really says is: Why don't you take these off the table, Mr. President, and submit them?

And, if you have some reservations on verification, state what those reservations are and submit the treaties to the Senate in that fashion. Let's dispose of these matters. They've been hanging around all this time, and there is a considerable amount of interest in their passage, to say the least. It was deemed in the best interests of the United States, first of all, to negotiate these treaties. And virtually every President has stated, as a matter of policy, that it makes good sense to work toward a comprehensive test ban treaty. So, we should at least talk about that—particularly since the Geneva talks are going on now where there is a good opportunity to raise the issue of the comprehensive test ban treaty and lay the whole matter open to discussion.

To those of us who support the pending resolution, it includes ample Presidential flexibility on the verification matter, aside from the obvious politics involved on either side. The resolution, moreover, states a very important policy position, because it builds on efforts to deal with the entire problem of reducing tensions and arms. The only sensible way to do this, of course, is to make the effort to negotiate and this resolution gives the President flexibility in the negotiations.

This administration has already undertaken to do this in the Geneva talks, so we see no reason therefore not to take the talks one step further——

Mr. Solarz. Mr. Chairman.

Chairman Fascell [continuing]. And ratify the two treaties that have been previously negotiated—and see if we can't lay on the table the question of a comprehensive test ban treaty.

Mr. Solarz. Will the gentleman——

Chairman Fascell. I understand the politics of it. But aside from that, it seems to me we've got a very reasonable position.

Mr. Solarz. If the gentleman will yield——

Chairman Fascell. I yield.

Mr. SOLARZ [continuing]. I support the resolution. But I would like to establish the legislative history of this undertaking. Mr. Chairman, as you know, there is some dispute in the scientific community about whether or not it is necessary to actually test the weapons in our stockpile in order to maintain the reliability of the stockpile.

As I understand it, in section 2 of the resolving clause, we call for the President to propose the immediate resumption of negotiations with the Soviet Union toward conclusion of a verifiable, comprehensive test ban treaty.

My impression is that the weight of the testimony from the scientific community is that you don't have to test actual weapons to assure the reliability of the stockpile, although there are some who feel that you do.

Would it be fair to say, Mr. Chairman, that the language of the resolution, particularly section 2 of the resolving clause, would leave the President the flexibility in negotiating a verifiable and comprehensive test ban treaty, to include in that treaty whatever arrangements were deemed necessary to maintain the reliability of our stockpile?

Chairman FASCELL. The gentleman is absolutely correct. Obviously, if there is a question—and there is, although I don't agree with the weight of the evidence that the gentleman has stated——

Mr. SOLARZ. No, no. I——

Chairman FASCELL [continuing]. But if there is a question mark, we want to be sure—and this language makes it perfectly clear that the question of reliability is a matter of negotiation for the President to satisfy himself on.

Mr. SOLARZ. Yes. I——

Chairman FASCELL. This does not preclude that issue.

Mr. SOLARZ. I thank the chairman for that clarification.

I said that the weight of the evidence, as I understood it, was that you didn't need to test to maintain reliability.

Chairman FASCELL. Well, I misunderstood you.

Mr. SOLARZ. But——

Chairman FASCELL. I agree with you on that.

Mr. SOLARZ. Yes; but there are some who say you do.

Chairman FASCELL. There is some dispute.

Mr. SOLARZ. And therefore, this is a matter, in effect, which would be resolved in the negotiations.

Chairman FASCELL. I would like to put in the record a statement by a number of scientists and arms control experts who support the position that continued nuclear testing is not necessary in order to ensure the reliability of nuclear weapons in our stockpile.[1]

But having said that there is still a dispute on this matter, as the gentleman from New York points out, and because we don't want to preclude that question from being negotiated—the language is broad enough so that the question of reliability becomes a matter of negotiation and a determination by the President and his advisers as to what needs to be done and how far they need to go.

Mr. SOLARZ. Thank you, Mr. Chairman.

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[1] See app. 11.

Mr. Leach, did you want to——

Mr. LEACH. Mr. Chairman, I think two points should be stressed—one, that reliability can be obtained by remaking the weapons all over again; second, that most testing that currently goes on and would go on in the future involves the nonnuclear testing of the mechanisms. That is another technique of reliability.

Finally, I think it should be stressed that the words "comprehensive test ban" includes the word "comprehensive," which implies that all testing will cease.

Certainly the flexibility of any administration in any negotiation is constitutionally guaranteed.

But in terms of applying meaning to the English language, I think we should all understand you can't have the "C" in comprehensive test ban and imply that some testing remains. This is an issue of profound significance, and it's the opinion of the gentleman from Iowa that comprehensive test ban means comprehensive.

Mr. HYDE. Mr. Chairman.

Chairman FASCELL. Mr. Hyde.

Mr. HYDE. Mr. Chairman, I don't delude myself that we're going to derail this locomotive. But nonetheless, I should like to register for the record my strong disapproval of House Joint Resolution 3.

First of all, we have two concepts we're dealing with here, the Threshold Test Ban Treaty, which was signed in 1974 but not ratified, and the Peaceful Nuclear Explosions Treaty signed in 1976 and not ratified.

The context in which ratification was suspended was the Afghanistan incursion—invasion by the Soviet Union. President Carter lost his enthusiasm for these two treaties because of the Soviet Union's aggression in Afghanistan.

From that day to this day, I have seen no change in the Soviet Union's attitude, except they have murdered Major Nicholson and they shot down an unarmed civilian airliner at the cost of 249 lives.

That aside, there are serious problems with verification. Now, I concede that the testimony from experts is divided. We heard some very credible, responsible, pedigreed, credentialed scientists say that verification can be had, even though it isn't onsite, because we know enough about the geological structure where they do these tests and we're able to allow for the decoupling—that is to say, setting a bomb off underground in a hole, which distorts the seismic waves. We can calculate for all that.

Now, we've heard those people. There are equally prestigious, credentialed, pedigreed scientists, who say: "Oh, no, it isn't adequate enough. We don't know. We can't measure whether they're living up to the 150-kiloton limit, which we have all been observing, without ratifying the treaties."

Now, when there is a dispute between scientists who are not political but are men of science, I think we owe it to this country to come down on the side that gives the benefit of the doubt to our national interests.

I am unwilling to leap ahead and trust the Soviets and trust one set of scientists when another set of scientists says: "Oh, no. Verification is very difficult."

Now, such scientists as Don Kerr, who heads the Los Alamos Laboratory—he has told us that we cannot tell adequately. I quote from his statement: "We concluded that the issue of Soviet compliance is unresolved, with the methods of verification that are presently available—unresolvable."

In essence, the problem involves uncertainties in measurement, encompassing both the nature of statistical measurement and the amount and accuracy of data available as well as the difficulties of translating these uncertainties into high-confidence conclusions about compliance.

Dr. Kerr, a responsible man who heads our Los Alamos testing grounds—and I quote from his statement: "All I'm saying, that there has been at least one occasion when a Soviet test has not been detected seismically."

Now, have we been trying to negotiate with the Soviet Union on enhanced verification techniques? Oh, yes, we have.

As I read House Joint Resolution 3, the paragraph at the bottom of the first page says: "Whereas the entry into force of the Peaceful Nuclear Explosions Treaty and the Threshold Test Ban Treaty will ensure full implementation"—now get this—"of significant new verification procedures and so make completion of a comprehensive test ban treaty more probable."

Do you know what those new verification procedures are? The exchange of data with the Soviet Union.

Now, raise your hands if you want to trust the Soviet Union to give good data on these things, just as they are encrypting the telemetry of their intercontinental ballistic missile tests.

I'm not ready to trust the safety of this country to data that they give us. But that's what they're referring to here.

Now, we have tried, again, and again, and again, to negotiate with the Soviet Union prior to ratifying these treaties—effective verification techniques. I won't read to you Dr. Kerr's whole statement, but he says: "Regrettably, the Soviets have thus far rejected all our proposals to meet and to confer on verification improvements."

Do we want to mandate to our President to go ahead and submit this for ratification without first having some method of effectively verifying what we're doing?

We say, "Well, we'll wait till later" or "We'll rely on the exchange of data."

You may be willing to do that; I am not.

Now, why is testing important?

Well, first of all, we dispose of mandating the Senate to ratify the Threshold Test Ban Treaty and the Peaceful Nuclear Explosions Treaty. I'm willing to do that when our scientists—when a respectable group of scientists—will tell us that effective verification methods have been negotiated with the Soviet Union.

If they don't even want to talk about it, why should we, with our tongue hanging out, panting for breath, say, "Here, we're going to ratify this now, and we'll work on verification later"?

Now, second, we have the other part of this, which is even more dangerous, and that is mandating the President to pose to the Soviet Union the immediate resumption of negotiations toward conclusion of a verifiable, comprehensive Test Ban Treaty.

This is a back-door freeze and not in the context of reductions. This tells Ambassador Kampelman, "You do your thing, Ambassador; we're going to do our thing"—"we ambassadors-at-large, with a portfolio that knows no bounds."

You've already negotiated with Gromyko an agenda; you're over there hard at work. Now, here we are—this isn't even micromanaging. This is macromanaging arms control discussions. We're telling the President, "You propose the immediate resumption of negotations toward conclusion of a verifiable, comprehensive Test Ban Treaty."

It is brain surgery with boxing gloves on. Can't we leave our negotiators and our Ambassadors over there without us instructing them over their shoulders, now that negotiations have begun, that this has to be done immediately?

I'm for a comprehensive test ban, following mutual, substantial reductions of these weapons. But for us to have this off to the side, compartmented, and immediately be going on is just stupid. It is just stupid.

Now, we must test if we're to have a credible deterrent.

Now, we've heard people say: "That's not necessarily so." Once more, we have a dichotomy, a diversion among the experts.

There are many experts who say to maintain confidence in our stockpile, which degrades and which deteriorates—even as you and I get old, we need to test to test—we need to test these new weapons that we're moving into, the age of the Midgetman.

Now, we're told, "Oh, no, we have warheads that will fit on the Midgetman. You need to test the vehicle, but you don't need to test the warhead."

I'm telling you, there's a dispute. And when there is a dispute, I come down on the side of safety for this country.

Now, I'm for all of the bans and for eliminating from the face of the Earth, et cetera, et cetera. But I'm telling you there is responsible, respectable, scientific authority that they can't be verified adequately, we ought to negotiate with the Soviets before we ratify the Threshold Test Ban Treaty, that the reasons for suspending those talks still exist—and that is the Afghanistan situation. And, second, comprehensive test ban ought to be a part of the negotiations in Geneva following on, not preceding, the reductions. And for us to interfere in that agenda, which is going on now, is wrong, it's not going to be effective.

And once more, ladies and gentlemen, we are masterful at negotiating with ourselves.

And so for those reasons and a few thousand more, I would hope we would not go ahead with House Joint Resolution 3. I don't expect that to happen. But we will continue this dialog—as you lawyers say—"in extenso" on the floor.

Chairman Fascell. The gentleman's time has expired.

Let me just interrupt the proceedings here to extend a greeting to a former distinguished colleague of ours who is taking a busman's holiday to come back and see what we are up to. Let me recognize Larry Winn who is back in town. [Applause.]

We are glad to see you back, Larry, looking so hearty, tanned, and fit from playing a lot of golf and lying around in the Sun. If you feel a little bit awkward right now, you can come up here, and we will give you 5 minutes.

Mr. WINN.[1] Thank you, Mr. Chairman.

Chairman FASCELL. Mr. Gilman.

Mr. GILMAN. Thank you, Mr. Chairman.

It is good to see our former colleague back with us. He used to nudge us every once in a while up here up on the top row to do the right things. Welcome back.

Mr. Chairman, the gentleman from Illinois has raised some very important points, and we are getting involved in a very technical argument about verification. I note that seated in the front row is Dr. Barker, the Deputy of the Bureau of Verification of the Arms Control Agency, and I would welcome hearing some comments from him with your permission, Mr. Chairman, with regard to this proposal.

Chairman FASCELL. Dr. Barker, please come up to the witness table.

He has already testified before the Subcommittee on Arms Control but we will be glad to hear from him again. He does not support this resolution, so he is going to tell you why.

Mr. GILMAN. I would welcome hearing those reasons, Mr. Chairman. Thank you.

STATEMENT OF ROBERT BARKER, DEPUTY ASSISTANT DIRECTOR FOR VERIFICATION AND INTELLIGENCE, ARMS CONTROL AND DISARMAMENT AGENCY

Mr. BARKER. Good morning, Mr. Chairman.

Chairman FASCELL. Could you put that microphone a little closer to you, Dr. Barker?

Mr. BARKER. Is it all right now?

Chairman FASCELL. Yes.

Mr. BARKER. As the chairman has noted, I did have the opportunity to speak to the subcommittee on this matter and informed the subcommittee at that time that the resolution is unacceptable to the administration.

Careful study led us 4 years ago to conclude that the Threshold Test Ban Treaty is not effectively verifiable. In the succeeding years, we have sought several times, including the last time when the President addressed the U.N. General Assembly, to get the Soviets to meet with us to improve the verification provisions of the Threshold Test Ban Treaty. We believe that the President cannot in good conscience seek the advice and consent of the Senate to ratification of a treaty which is not in the national security interests of the United States. Until the Threshold Test Ban Treaty is effectively verifiable, it is not in the best interests of this country.

With respect to the Comprehensive Test Ban Treaty, that issue was also studied very extensively, and this administration, as many administrations have before—in fact, the last seven—have reaffirmed the goal of a Comprehensive Test Ban Treaty. A Comprehensive Test Ban Treaty is a long-term goal of this country, but one which must be sought in the context of deep and verifiable arms control reductions and with an eye toward maintaining a credible nuclear deterrent.

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[1] Hon. Larry Winn, former Republican Member of Congress from the State of Kansas.

We are right now engaged in what we believe is the highest priority—should be the highest priority for this country—namely, negotiating deep reductions in nuclear weaponry. We are very hopeful that those negotiations will proceed satisfactorily in Geneva.

The debate, the discussion, that has occurred in conjunction with the Strategic Defense Program has caused, I think, more people than have thought about it recently to think about the nuclear deterrent and the importance of the nuclear deterrent. And not only have many American citizens but many of our allies have strongly encouraged us to maintain the reliability of that nuclear deterrent and to depend upon it until some better alternative is available.

Dr. Kerr, director of the Los Alamos National Laboratory, who testified to the subcommittee a week ago, is one of the two gentlemen in this country who direct the two nuclear weapons laboratories. Those are the individuals to whom the President and the country needs to turn to, in asking the question: Can stockpile reliability be maintained during a comprehensive test ban?

Those are the individuals whose name and whose reputation is on the line, and while many well-meaning and well-credentialed people may have another opinion, they are not the ones who are responsible to the President of the United States for the reliability of the deterrent. So a comprehensive test ban remains a long-term goal, but a goal in the context of deep reductions and with an eye toward maintaining reliability in the deterrent.

Mr. HYDE. Would the gentleman yield?

Would the gentleman be pleased to yield?

Mr. GILMAN. Just one moment.

Mr. Barker, just one question, in the measure, it says, "Whereas the Comprehensive Test Ban Treaty must be adequately verifiable and significant progress has been made in methods for detection of underground nuclear explosions by seismological and other means," are you convinced of the accuracy of that statement?

Mr. BARKER. This country has spent hundreds of millions of dollars on trying to improve the verification of nuclear test limitations; and certainly progress has been made. But it is not the position of this administration, and it is not the position of many qualified technical people that we can currently verify with sufficient accuracy a comprehensive test ban—that is, detect tests of low yield with sufficient accuracy, with sufficient confidence, to have an effectively verifiable treaty.

Mr. GILMAN. Thank you, Doctor.

I will be pleased to yield to the gentleman from Illinois.

Mr. HYDE. Doctor, why would a Comprehensive Test Ban Treaty interfere with the mutual and balanced reductions of nuclear weapons which is our primary goal at Geneva?

Mr. BARKER. I think that the answer to that question comes in two spheres. Of course, one is the diversion of energies. I think that we should focus our intensity on what we believe has the highest priority, and that highest priority, I think the whole world appreciates, is a dramatic reduction in the number of nuclear weapons. Nuclear weapons are the threat; that is what people are concerned about, and we ought not to allow our energies to be diluted by measures that do not directly contribute to that objective.

At the same time, while we are as dependent as we are upon those nuclear weapons, the current deterrent, we are not in a position to negotiate a comprehensive test ban because of the threat that such a ban would pose to our ability to maintain the reliability of the deterrent.

Mr. Hyde. Would it not be a disincentive to the Soviets to reduce if they have got us locked in to our present status on intercontinental ballistic missiles while they have their four generations of modern ones?

If they can lock us into that, what incentive have they got to reduce?

Mr. Barker. I agree with the Congressman that the time is certainly not ripe in terms of the current strategic balance.

Chairman Fascell. Well, Doctor——

Mr. Zschau. Will the gentleman yield?

Mr. Gilman. The gentleman from California had asked——

Chairman Fascell. Mr. Lagomarsino is next.

Mr. Lagomarsino. Doctor.

Could I ask you a question? I was going to do it while you were still there, but you did not get too far away.

Mr. Barker. I am sorry.

Mr. Lagomarsino. What is the position of our negotiators in Geneva on this resolution? Are they asking for it?

Mr. Barker. I have no indication whatsoever that the negotiators in Geneva have taken a position on it. I am sure that their entire attention is focused strongly on what they have been asked to do, namely, to negotiate significant reductions.

Chairman Fascell. I think in all fairness we need to turn that around.

The negotiators are instructed by the President to do what he asks and nothing else.

Mr. Lagomarsino. OK. That is true.

Mr. Barker. Yes.

Mr. Lagomarsino. But they have not indicated this would be helpful to them in carrying out the——

Mr. Barker. They have not.

Mr. Zschau. Will the gentleman yield?

Mr. Lagomarsino. Yes, for a brief moment. I have a statement I want to make.

Mr. Zschau. I have a question for Dr. Barker.

Have the Soviets been conducting tests that exceed the threshold in the treaty even though it is unratified?

Mr. Barker. Since 1976 both the United States and the Soviet Union indicated that they would abide by the provisions of the Threshold Test Ban Treaty even though it was not ratified. In the President's report to the Congress in January 1984, and in February 1985, he stated that a study of the Soviet test programs since 1976 led the administration to the conclusion that while there were ambiguities in the data, it was likely that the Soviets had, on several occasions, violated the 150-kiloton threshold.

Mr. ZSCHAU. Would that suggest that there are means, then, for verifying whether they are below the threshold or above the threshold?

Chairman FASCELL. They had to at least guess.

Mr. BARKER. The statement includes the very clear caveat that there are uncertainties associated with the conclusion of the likely violation. The mechanism that is available to us to estimate Soviet yield depends upon a phenomenon which is statistical, the seismic signal that we observe is not associated with a single yield, but with a yield range, an uncertainty. We have detected a significant number of events since 1976 where a large part of that yield range is above the 150-kiloton threshold.

One might expect a small number of such events, even if all tests were below 150 kilotons. But a large number of those events had a substantial part of their range above 150 kilotons. When one combines that with other data of a more sensitive nature which cannot be discussed in this room at this time, the administration came to the conclusion that although there were uncertainties, although there were ambiguities, it was likely that the Soviet Union was in violation of the obligation.

Mr. ZSCHAU. If the gentleman would yield further, have we to your knowledge violated the unratified Threshold Treaty?

Mr. BARKER. We have not violated it.

Mr. ZSCHAU. We have continued our modernization program without violating the treaty?

Mr. BARKER. The directors from the two nuclear weapons laboratories have, I believe, testified to Congress that they, based upon a current and existing military requirements, as stated by the Secretary of Defense and the Joint Chiefs, could continue to meet those needs while testing below the 150-kiloton threshold.

Mr. ZSCHAU. I thank the gentleman.

Mr. BERMAN. Will the gentleman yield on that?

Chairman FASCELL. Mr. Berman.

Mr. BERMAN. I thank the gentleman for yielding.

Would it be possible under this scenario that you have constructed in response to Mr. Zschau's questions that the Soviet Union might consider that there have been U.S. tests which have a range of explosive power, a portion of which may be above the 150-kiloton threshold.

Mr. BARKER. If we can take their statements at face value, we can be sure of it. They have several times issued diplomatic statements to us, accusing us of violating the treaty. I have not yet seen the article, but I gather in Pravda of the 12th of May those charges were restated.

I think that if they are making those charges in sincerity, and not solely on a tit-for-tat basis in response to our expression of concern, it should heighten their interest in meeting with us to improve the verification provisions of the Threshold Test Ban Treaty.

To date, unfortunately, they have not responded positively to any of our four or five suggestions that we meet to try and establish a better basis for verification.

Mr. BERMAN. I yield——

Chairman FASCELL. That goes back to the fact that we have been testing at a threshold that is within the context of the treaty.

Mr. Barker. We have not exceeded the 150-kiloton threshold.

Mr. Berman. But the Soviets think——

Mr. Barker. But the Soviets have accused us of it; what they think, I do not know.

Chairman Fascell. And also we have not done any testing dealing with the reliability of the stockpile, have we?

Mr. Barker. We have, Mr. Chairman. Luckily, the kinds of problems that would require nuclear testing for their resolution have been rare in the history of the nuclear stockpile.

Nuclear weapons or weapons systems in the stockpile have tended to be turned over and totally changed in a number of years, 6 or 7, 8 years; the kinds of problems that have come up have usually happened with weapons which were older than that.

I would say that the number of tests that have been required because of stockpile reliability problems, stockpile aging problems, have probably been less than a handful in the whole history of the nuclear stockpile.

But when they have happened, nuclear testing was the only way in which the directors of the laboratories felt that they could resolve those issues with high enough confidence to feel confident in the stockpile.

Chairman Fascell. Thank you very much, Doctor.

We will recess——

Mr. Barker. Thank you.

Chairman Fascell [continuing]. Until this vote is over.

[Recess.]

Chairman Fascell. The committee will recess until 1:30 p.m.

[Whereupon, at 11:54, the hearing was in recess, to be reconvened at 1:30 p.m.]

AFTERNOON SESSION

Chairman Fascell. The committee will resume its consideration of House Joint Resolution 3.

And the gentleman from Indiana, Mr. Hamilton.

Mr. Hamilton. Mr. Chairman, I move the adoption of the resolution, House Joint Resolution 3.

Chairman Fascell. All those in favor of the adoption of the resolution signify by saying "aye."

[Chorus of ayes.]

Chairman Fascell. All those opposed, signify by saying "no."

Mr. Hyde. No.

Chairman Fascell. The ayes appear to have it.

The ayes have it, and the resolution is reported.

And I thank you gentlemen, all of you.

[Whereupon, at 2:31 p.m., the committee was adjourned.]

APPENDIX 1

99TH CONGRESS
1ST SESSION

H. J. RES. 3

To prevent nuclear explosive testing.

IN THE HOUSE OF REPRESENTATIVES

JANUARY 3, 1985

Mr. BEDELL (for himself, Mr. LEACH of Iowa, and Mr. MARKEY) introduced the following joint resolution; which was referred to the Committee on Foreign Affairs

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JOINT RESOLUTION

To prevent nuclear explosive testing.

Whereas the United States is committed in the Limited Test Ban Treaty of 1963 and in the Non-Proliferation Treaty of 1968 to seek to achieve the discontinuance of all test explosions of nuclear weapons for all time;

Whereas a comprehensive test ban treaty would promote the security of the United States by constraining the United States-Soviet nuclear arms competition and by strengthening efforts to prevent the proliferation of nuclear weapons;

Whereas the Threshold Test Ban Treaty was signed in 1974 and the Peaceful Nuclear Explosions Treaty was signed in 1976, and both have yet to be considered by the full Senate for its advice and consent to ratification;

Whereas the entry into force of the Peaceful Nuclear Explosions Treatv and the Threshold Test Ban Treaty will ensure full implementation of significant new verification procedures and so make completion of a comprehensive test ban treaty more probable;

Whereas a comprehensive test ban treaty must be adequately verifiable, and significant progress has been made in methods for detection of underground nuclear explosions by seismological and other means;

Whereas, at present, negotiations are not being pursued by the United States and the Soviet Union toward completion of a comprehensive test ban treaty; and

Whereas the past five administrations have supported the achievement of a comprehensive test ban treaty: Now, therefore, be it

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That at the earliest possible date, the President of the United States should—

(1) request advice and consent of the Senate to ratification (with a report containing any plans the President may have to negotiate supplemental verification procedures, or if the President believes it necessary, any understanding or reservation on the subject of verification which should be attached to the treaty) of the Threshold Test Ban and Peaceful Nuclear Explosions Treaties, signed in 1974 and 1976, respectively; and

(2) propose to the Soviet Union the immediate resumption of negotiations toward conclusion of a verifiable comprehensive test ban treaty.

In accordance with international law, the United States shall have no obligation to comply with any bilateral arms control agreement with the Soviet Union that the Soviet Union is violating.

APPENDIX 2

99th CONGRESS
1st Session

H. J. RES. 119

Entitled: the "Nuclear Test Ban Challenge".

IN THE HOUSE OF REPRESENTATIVES

January 31, 1985

Mrs. Boxer (for herself and Mr. Mavroules) introduced the following joint resolution; which was referred to the Committee on Foreign Affairs

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JOINT RESOLUTION

Entitled: the "Nuclear Test Ban Challenge".

Whereas the momentum of the nuclear arms race can only be broken by a clear commitment to waging peace, and the responsibility to prevent ultimate nuclear destruction lies with the world superpowers;

Whereas the United States and the Soviet Union conduct underground tests on an ongoing basis;

Whereas United States Presidents Eisenhower, Kennedy, Johnson, Nixon, Ford, and Carter have supported negotiations for a comprehensive test ban treaty, and no such negotiations are being planned presently;

Whereas continued testing of nuclear weapons is contrary to the spirit of the Limited Test Ban Treaty of 1963 and the Non-Proliferation Treaty of 1968;

Whereas a comprehensive test ban must be adequately verifiable;

Whereas technology currently exists to verify compliance with such a test ban; and

Whereas significant progress in reducing the nuclear threat will not occur unless one nuclear power takes the first step: Now, therefore, be it

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That at the earliest possible date the President should—

(a) announce to the Soviet Union and other nuclear nations that the United States will suspend testing of nuclear weapons;

(b) challenge the Soviet Union and other nuclear powers to do likewise;

(c) express to the diplomatic community that the policy of the United States is to cease testing nuclear weapons, and that testing will be resumed only if the Soviet Union proceeds with further underground testing of nuclear weapons;

(d) ensure that upon suspension of United States testing, the United States shall make use of existing technology and equipment and take whatever other steps are necessary to verify that nuclear explosions have ceased; and

(e) initiate negotiations for a permanent United States-Soviet comprehensive test ban treaty.

APPENDIX 3

99TH CONGRESS
1ST SESSION

H. J. RES. 47

To renounce the first use of all nuclear weapons and to conclude treaties with all nations renouncing the first use of all nuclear weapons.

IN THE HOUSE OF REPRESENTATIVES

JANUARY 3, 1985

Mr. WEISS introduced the following joint resolution; which was referred to the Committee on Foreign Affairs

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JOINT RESOLUTION

To renounce the first use of all nuclear weapons and to conclude treaties with all nations renouncing the first use of all nuclear weapons.

Whereas the United States and the Soviet Union both have developed nuclear weaponry to retaliate to a nuclear attack with equal or even greater force;

Whereas this capability for retaliation has created a condition of mutual deterrence;

Whereas the delicate balance of mutual deterrence has provided a disincentive to actual nuclear warfare;

Whereas the United States and the Soviet Union both are moving toward development in both the strategic and tactical nuclear realms of first-use capabilities;

Whereas the increasing feasibility of the first-use option heightens tensions on both sides and undermines mutual deterrence;

Whereas continued pursuit and refinement of the first-use option will encourage preemptive nuclear attack;

Whereas exercise of the first-use option, whether tactical or strategic, will result in a full-scale nuclear exchange and the subsequent destruction of much of civilization;

Whereas the United States and all nations face no more solemn duty than preventing a nuclear cataclysm;

Whereas this duty can best be fulfilled by maintaining mutual deterrence at lower levels than currently exist, and by working toward the elimination of all nuclear weapons; and

Whereas renouncing the first use of all nuclear weapons is consonant with these obligations and aims: Now, therefore, be it

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That it shall be the policy of the United States to renounce the first use of all nuclear weapons and to conclude treaties with all nations renouncing the first use of all nuclear weapons.

APPENDIX 4

99TH CONGRESS
1ST SESSION

H. R. 1834

To provide for a mutual, simultaneous, verifiable cessation of the testing of nuclear warheads effective on August 6, 1985, and for other purposes.

IN THE HOUSE OF REPRESENTATIVES

MARCH 28, 1985

Mrs. SCHROEDER introduced the following bill; which was referred jointly to the Committees on Armed Services and Foreign Affairs

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A BILL

To provide for a mutual, simultaneous, verifiable cessation of the testing of nuclear warheads effective on August 6, 1985, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE.

This Act may be cited as the "Simultaneous Nuclear Test-Ban Act".

SEC. 2. FINDINGS.

The Congress finds—

(1) that the mutual and simultaneous cessation of the testing of nuclear warheads by the United States and the Soviet Union would give a positive indication

of a sincere desire by both nations to end the nuclear arms race; and

(2) that such an indication would provide the proper climate for current and future nuclear arms control negotiations.

SEC. 3. SENSE OF CONGRESS.

(a) CESSATION OF NUCLEAR TESTING.—(1) It is the sense of Congress that the President, before August 6, 1985, should declare that the United States will begin a three-month cessation of the testing of nuclear warheads effective on that date if before that date the Soviet Union makes a similar declaration that effective on that date the Soviet Union will begin a three-month cessation of the testing of nuclear warheads.

(2) If such a cessation of the testing of nuclear warheads takes effect, the United States should continue the cessation of the testing of nuclear warheads indefinitely unless and until the President certifies to Congress that the Soviet Union has conducted a test of a nuclear warhead after August 6, 1985.

(b) RESUMPTION OF COMPREHENSIVE TEST BAN TALKS.—It is the sense of Congress that during a cessation of the testing of nuclear warheads described in subsection (a) the President should seek resumption of the comprehensive test ban talks between the United States, Great Britain, and the Soviet Union.

SEC. 4. LIMITATION ON USE OF FUNDS.

(a) In General.—If the President does not declare a cessation of testing nuclear warheads as described in section 3(a), then during the three-month period beginning on August 6, 1985, no funds appropriated or otherwise made available by Congress may be obligated or expended by the United States for the testing of nuclear warheads.

(b) Authority if Soviet Union Tests.—(1) If the President certifies to Congress after August 6, 1985, that the Soviet Union has on or after that date tested a nuclear warhead, then beginning on such date funds may be obligated or expended by the United States for such testing.

(2) The President shall include with any certification under this subsection—

(A) an unclassified report summarizing the basis for the certification; and

(B) a classified report describing in detail the activities of the Soviet Union that are the basis for the certification.

SEC. 5. VERIFICATION OF CESSATION OF TESTING.

Existing national technical means of verification are adequate to provide confidence during the initial three-month period of the cessation of nuclear testing that no nuclear test can be conducted that would lead to a military advantage for either participant. The comprehensive test ban talks referred to in section 3(b) can build upon verification procedures already developed and incorporated in previous treaties and agreements to provide long-term mutually acceptable verification measures. These verification measures would include, at a minimum, provisions for on-site inspection, cooperative measures for the exchange of seismic data, and the establishment of a monitoring committee of experts.

SEC. 6. ANNUAL REPORT.

Three months after a cessation of the testing of nuclear warheads takes effect under this Act and annually thereafter while such cessation remains in effect, the President shall report to Congress—

(1) on the progress being made by the United States in negotiating nuclear arms control agreements with the Soviet Union; and

(2) on whether the President believes that continuation of the cessation of nuclear testing is in the national security interest of the United States.

SEC. 7. DEFINITION.

For purposes of this Act, the term "testing of nuclear warheads" means the detonation of a nuclear explosive device.

APPENDIX 5

Tripartite Report to the Committee on Disarmament (July 1980)

PUBLIC AFFAIRS ADVISER
UNITED STATES ARMS CONTROL AND DISARMAMENT AGENCY

August 5, 1980

The attached tripartite report on the progress of the Comprehensive Test Ban negotiations, which was prepared jointly by the United States, the United Kingdom and the Soviet Union, was transmitted July 31 to the Committee on Disarmament in Geneva.

Although previous reports have been made available to the 40-member Committee by the negotiators, this was by far the most informative one. This also was the first time the three parties have jointly prepared a document that outlines in a comprehensive way those aspects of a Comprehensive Test Ban treaty that have been agreed to on a trilateral basis.

As the joint report points out, "despite significant accomplishments, there are important areas where there is substantial work still to be done." Many of the issues remaining to be resolved are technically complex and politically sensitive, and it is not possible for us to predict when a treaty will be completed.

The outstanding issues fall primarily in the area of verification. A particularly important area where further work needs to be done is on detailed provisions regarding seismic verification of the treaty.

Tom Halsted

Thomas A. Halsted

COMMITTEE ON DISARMAMENT

CD/150
30 July 1980

ENGLISH
Original: ENGLISH/RUSSIAN

LETTER DATED 30 JULY 1980 FROM THE PERMANENT REPRESENTATIVES OF THE UNION OF SOVIET SOCIALIST REPUBLICS, THE UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND AND THE UNITED STATES OF AMERICA TRANSMITTING A DOCUMENT ENTITLED "TRIPARTITE REPORT TO THE COMMITTEE ON DISARMAMENT"

We have the honour to transmit the attached document entitled "Tripartite Report to the Committee on Disarmament". We request that it be circulated for the information of the Committee on Disarmament.

(Signed) V.L. Issraelyan
Representative of the
Union of Soviet Socialist
Republics

(Signed) D. Summerhayes
Representative of the
United Kingdom of Great Britain
and Northern Ireland

(Signed) C.C. Flowerree
Representative of the
United States of America

TRIPARTITE REPORT TO THE COMMITTEE ON DISARMAMENT

1. This report on the status of the negotiations between the Union of Soviet Socialist Republics, the United Kingdom of Great Britain and Northern Ireland and the United States of America on a treaty prohibiting nuclear weapon test explosions in all environments and its protocol covering nuclear explosions for peaceful purposes has been jointly prepared by the three parties to the negotiations.

2. The three negotiating parties are well aware of the deep and long-standing commitment to the objective of this treaty that has been demonstrated by the Committee on Disarmament and its predecessor bodies. They recognize the strong and legitimate interest of the Committee on Disarmament in their activities, and they have reported to the Committee on Disarmament previously, most recently on 31 July 1979. They welcome the opportunity to do so again, just as they welcome the continued support and encouragement that their negotiations derive from the interest of the Committee on Disarmament.

3. Since the last report to the Committee on Disarmament, the three delegations have completed two rounds of negotiations. The negotiations reconvened on 16 July 1980.

4. The negotiating parties are seeking a treaty that for decades has been given one of the highest priorities in the field of arms limitation, and the Soviet Union, the United Kingdom and the United States continue to attach great importance to it. The desire to achieve an early agreement, which is so widely shared by the international community, has been repeatedly expressed at the highest level of all three governments.

5. Global interest in the cessation of nuclear weapon tests by all States has been recorded by a succession of resolutions of the United Nations General Assembly and by the Final Document of the Special Session on Disarmament of the United Nations General Assembly. It has been stated in the preambles to a number of international arms limitation treaties now in force, and its significance will again be underlined in the forthcoming second Review Conference of the Treaty on the Non-Proliferation of Nuclear Weapons.

6. The objectives which the negotiating parties seek to achieve as a result of this treaty are important to all mankind. Specifically, they seek to attain a treaty which will make a major contribution to the shared objectives of constraining the nuclear arms race, curbing the spread of nuclear weapons, and strengthening international peace and security.

7. Given the importance of these objectives, it is understandable that the international community has repeatedly called for the earliest possible conclusion of the treaty. At the same time, it is important to note that this treaty is, in many respects, a difficult one to negotiate. Many of the issues are novel, sensitive and intricate. The treaty directly affects vital national security concerns and the process of negotiation requires considerable and painstaking work.

8. In spite of these challenges, however, the Soviet Union, the United Kingdom and the United States have made considerable progress in negotiating the treaty.

9. The negotiating parties have agreed that the treaty will require each party to prohibit, prevent and not to carry out any nuclear weapon test explosion at any place under its jurisdiction or control in any environment; and to refrain from causing, encouraging or in any way participating in the carrying out of any nuclear weapon test explosion anywhere.

10. The negotiating parties have agreed that the treaty will be accompanied by a protocol on nuclear explosions for peaceful purposes, which will be an integral part of the treaty. The protocol will take into account the provisions of Article V of the Treaty on the Non-Proliferation of Nuclear Weapons. In the protocol, the parties will establish a moratorium on nuclear explosions for peaceful purposes and accordingly will refrain from causing, encouraging, permitting or in any way participating in, the carrying out of such explosions until arrangements for conducting them are worked out which would be consistent with the treaty being negotiated, the Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water and the Treaty on the Non-Proliferation of Nuclear Weapons. Without delay after entry into force of the treaty, the parties will keep under consideration the subject of arrangements for conducting nuclear explosions for peaceful purposes, including the aspect of precluding military benefits. Such arrangements, which could take the form of a special agreement or agreements, would be made effective by appropriate amendment to the protocol.

11. To ensure that the treaty does not detract from previous arms limitation agreements, there will be a provision stating that the treaty does not affect obligations compatible with it that have been assumed by parties under other international agreements. Such other agreements include the Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water and the Treaty on the Non-Proliferation of Nuclear Weapons. The three negotiating parties have agreed that the treaty will provide procedures for amendment, and that any amendments will require the approval of a majority of all parties, which majority shall include all parties that are permanent members of the Security Council of the United Nations. They have also agreed that, as in other arms limitation agreements, there will be provision for withdrawal from the treaty on the grounds of supreme national interests. They have also agreed that the treaty should enter into force upon ratification by twenty signatory governments, including those of the Soviet Union, the United Kingdom and the United States.

12. The parties are considering formulations relating to the duration of the treaty. They envisage that a conference will be held at an appropriate time to review the operation of the treaty. Decisions at the conference will require a majority of the parties to the treaty, which majority shall include all parties that are permanent members of the Security Council of the United Nations.

13. The negotiating parties, recognizing the importance of verification, have agreed that a variety of verification measures should be provided to enhance confidence that all parties to the treaty are in strict compliance with it. Such measures in the treaty itself, and the additional measures under negotiation to facilitate verification of compliance with the treaty, must first be agreed in principle, and then drafted in detail, which is of course a laborious process. It must be done with care because the implementation of these measures will have important impact not only on ensuring compliance with the treaty, but also on political relations among its parties.

14. It has been agreed that the parties will use national technical means of verification at their disposal in a manner consistent with generally recognized principles of international law to verify compliance with the treaty, and that each party will undertake not to interfere with such means of verification.

15. It has long been recognized that co-operative seismic monitoring measures can make an important contribution to verifying compliance with the treaty. The Committee on Disarmament and its predecessors have played a leading role in developing such measures. On the basis of the work done in the past few years under those auspices, the negotiating parties have agreed to provisions establishing an International Exchange of Seismic Data. Each treaty party will have the right to participate in this exchange, to contribute data from designated seismic stations on its territory, and to receive all the seismic data made available through the International Exchange. Seismic data will be transmitted through the Global Telecommunications System of the World Meteorological Organization or through other agreed communications channels. International seismic data centres will be established in agreed locations, taking into account the desirability of appropriate geographical distribution.

16. A Committee of Experts will be established to consider questions related to the International Seismic Data Exchange and all treaty parties will be entitled to appoint representatives to participate in the work of the Committee. The Committee of Experts will be responsible for developing detailed arrangements for establishing and operating the International Exchange, drawing on the recommendations of the Ad Hoc Group of Scientific Experts, which was established under the auspices of the Conference of the Committee on Disarmament and has continued its work under the Committee on Disarmament. Arrangements for establishing and operating the International Exchange will include the development of standards for the technical and operational characteristics of participating seismic stations and international seismic data centres, for the form in which data are transmitted to the centres, and for the form and manner in which the centres make seismic data available to the participants and respond to their requests for additional seismic data regarding specified seismic events.

17. In addition to its role in setting up the International Exchange, the Committee of Experts will have ongoing responsibility for facilitating the implementation of the International Exchange, for reviewing its operation and considering improvements to it, and for considering technological developments that have a bearing on its operation. The Committee will serve as a forum in which treaty parties may exchange technical information and co-operate in promoting the effectiveness of the International Exchange. The Committee of Experts will hold its first meeting not later than 90 days after the entry into force of the treaty and will meet thereafter as it determines.

18. The negotiating parties have agreed to other co-operative measures as well. There will be provision in the treaty for direct consultations, and for the exchange of inquiries and responses among treaty parties in order to resolve questions that may arise concerning treaty compliance. If a party has questions regarding an event on the territory of any other party, it may request an on-site inspection for the purpose of ascertaining whether or not the event was a nuclear explosion. The requesting party shall state the reasons for its request, including appropriate evidence. The party which receives the request, understanding

the importance of ensuring confidence among parties that treaty obligations are being fulfilled, shall state whether or not it is prepared to agree to an inspection. If the party which receives the request is not prepared to agree to an inspection on its territory, it shall provide the reasons for its decision. Tripartite agreement on these general conditions with regard to on-site inspections represents an important achievement by the negotiating parties in resolving issues regarding verification of compliance with the treaty.

19. The three negotiating parties believe that the verification measures being negotiated — particularly the provisions regarding the International Exchange of Seismic Data, the Committee of Experts, and on-site inspections — break significant new ground in international arms limitation efforts and will give all treaty parties the opportunity to participate in a substantial and constructive way in the process of verifying compliance with the treaty.

20. The treaty will also contain a provision permitting any two or more treaty parties, because of special concerns or circumstances, to agree by mutual consent upon additional measures to facilitate verification of compliance with the treaty. The three negotiating parties have agreed that it is necessary to develop such additional measures for themselves in connexion with the treaty under negotiation.

21. The additional measures to facilitate verification of compliance with the treaty, while paralleling those of the treaty itself, will specify in greater detail the procedures under which on-site inspection would be conducted, and will incorporate a list of the rights and functions of the personnel carrying out the inspection. They will also contain a description of the role to be played by the host party during an inspection.

22. In addition, the three parties are negotiating an exchange of supplemental seismic data. This would involve the installation and use by the three parties of high-quality national seismic stations of agreed characteristics.

23. Despite significant accomplishments, there are important areas where substantial work is still to be done.

24. The three negotiating parties have demonstrated their strong political commitment to completion of this treaty by achieving solutions to problems that for many years made a treaty difficult to attain. Most notable in this regard are the agreements concerning the prohibition of any nuclear weapon test explosion in any environment, the moratorium on nuclear explosions for peaceful purposes, the general conditions with regard to on-site inspections, and a number of important seismic verification issues.

25. The negotiating parties are mindful of the great value for all mankind that the prohibition of nuclear weapon test explosions in all environments will have, and they are conscious of the important responsibility placed upon them to find solutions to the remaining problems. The three negotiating parties have come far in their pursuit of a sound treaty and continue to believe that their trilateral negotiations offer the best way forward. They are determined to exert their best efforts and necessary will and persistence to bring the negotiations to an early and successful conclusion.

APPENDIX 6

MAY 1985 REPORT BY JACK F. EVERNDEN* ENTITLED "SEVERAL ASPECTS OF VARIOUS TEST BAN TREATIES"

Several Aspects of Various Test Ban Treaties

(May 1985)

Jack F. Evernden*

Introduction

This article presents a brief account of the scientific bases for the assertion that there is no technical obstacle to negotiation of verifiable test ban treaties of various sorts. The article is intended to be complete unto itself while at the same time being complementary to an earlier article (Scientific American, October 1982).

Political aspects have been for many years the truly ruling considerations in negotiation of test ban treaties even though many have claimed and many have believed technical considerations to be paramount. This delusion has been incredibly unfortunate. However, even if one once believed that technical considerations were of ruling importance relative to attainment of a Comprehensive Test Ban Treaty (CTBT) or a Low Threshold Test Ban Treaty (LTTBT), that belief can no longer be held. Technical understanding of the seismological aspects of monitoring such treaties is now essentially complete and we know that a low threshold treaty can be successfully monitored. Only a few details relative to seismological properties of the USSR need to be ascertained in order to establish the exact quantitative limits on attainable capability. The general parameters of that capability are already known. This knowledge extends to detection of the seismic signals of explosions, to the identification of those signals as being the product of underground explosions rather than earthquakes, and to establishment of the yield of the explosion to within factors of uncertainty of no relevance to meaningful monitoring. No longer is it possible to assert that seismological monitoring of a low yield threshold treaty is unattainable by a negotiable treaty. The problem today is lack of political will, not technical incompetence.

I humbly write this paper in the hope that it and other articles by other authors may finally have sufficient collective impact on the rational part of the collective human mind that sane solutions to our problems can be implemented. Such solutions have long been known. But implementation of a rational solution to a political problem is vastly harder than finding the solution. Why does not the simple fact that we on this scrap of rock called Earth are the only animate life within at least 40 trillion kilometers of our sun have impact on our collective behavior? Why does not the risk of extinguishing the products of 5 billion years of evolution influence our acts? How can men responsible for the fate of us all still have the short range myopic vision of their ancestors? Perplexing indeed.

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*The views expressed in this paper are those of the author and are not necessarily those of the US Geological Survey or the US Government.

Seismic Waves

In discussing seismological details, we will focus on those properties of the seismic waves of explosions and earthquakes which: (a) are of most use in identifying source type; and (b) which have allowed demonstration that observations quantitatively substantiate theoretical predictions, thus confirming our state of near-total understanding. Such an elastic body as the earth supports two types of waves propagating throughout the body of the earth as well as two types of waves propagating over its surface. The body waves are known to seismologists as P and S waves, to many scientists as longitudinal or compressional and transverse or shear waves, respectively. Sound waves in air and water and waves moving up and down vertical coil springs are analogues of compressional (P) waves in the earth, all of these wave types being characterized by the material particles of the various media moving parallel to the direction of propagation of the wave as the wave passes. Waves in vibrating strings are analogues of shear (S) waves in rocks, these wave types being characterized by the material particles of the string or rock moving transverse to the direction of propagation of the wave. The marked increase in velocity of both P and S waves at a depth of 40 to 60 kilometers in the earth at the Mohorovicic Discontinuity (Moho) leads to waves that are trapped in the low velocity crust of the earth. Over much of the earth, most particularly over most of the USSR, these waves have high amplitudes at distances of 0 to 1000 kilometers or so from the seismic source, and these waves will be the bases for detection and identification of small explosions and earthquakes.

Surface waves are characterized not by detection at the surface, but by restriction of sensible amplitudes of particle motion to quite near the surface of the earth. The two types of surface waves, called Rayleigh and Love waves, are distinguished by their character of particle motion. Waves moving over the surface of water (or along the top of the atmosphere) are analogues of Rayleigh waves in the earth, material particles of these media moving in vertical circles or ellipses in the plane of wave propagation. Love waves are characterized by particle motion solely transverse to the direction of wave propagation (as with S waves) but in the plane of the earth's surface. Since the shear strengths of air and water are zero, these media cannot support Love waves. Rayleigh waves can be detected by seismometers sensitive either to vertical or horizontal motion of the earth's surface whereas Love waves are detectable only by horizontal seismometers. Generally, both types of surface waves are detected at periods of 10 to 40 seconds. Seismic noise (induced by various atmospheric processes) of 10 to 40 second period is usually far greater on horizontal seismometers than on vertical seismometers. Thus, most surface wave measurements in the past have been based on detection of Rayleigh waves by vertical seismometers. Recently, the problem of achieving comparable noise levels on both horizontal and vertical seismometers has been solved, leading to extensive observations of Love waves of quite small earthquakes. However, the small earthquakes and explosions requiring monitoring under a CTBT or LTTBT will not generate detectable long period surface waves of either type. Discussion of these wave types is included in this paper for a variety of historical and theoretical reasons that will appear below.

Characteristics of Seismic Waves of Simple Explosions

In the simplest case, the seismic signal from an explosion can be well modeled as an instantaneous application of a high pressure to the wall of a spherical cavity in an unstrained material. If the cavity is too small, the applied pressure exceeds the strength of the rock and highly disruptive effects occur in the rock surrounding the explosion. In this case, radiated amplitudes are dictated by size of the explosion, size of the cavity, strength of the rock, and distance at which the step pressure induced in the rock by the explosion drops to the elastic strength of the rock. For a given explosion and strength of rock, the smaller the cavity the greater the distance to elastic behavior of the rock and the greater the amplitude of radiated signal. Up to a critical size, the converse is true, i. e., the larger the cavity the smaller the amplitude of the radiated signal. The critical size is that at which the pressure within the cavity is equal to the strength of the rock, this condition being spoken of as that for "full decoupling". At this and greater cavity radii, the radiated amplitude of P waves at low frequencies has a uniform value about 1/200 of that for the same explosion in a hole just adequate to hold the explosive device (a "tamped" explosion). Under the reasonable assumption that the critical cavity pressure, at least for rocks such as granite, is that at which the rocks go into tension (all near-surface rocks are fractured and thus have zero strength in tension), the critical radius for full decoupling of a one kiloton explosion at a depth of 2000 meters is 16.5 meters while the radius to elastic rock behavior of a tamped one kiloton explosion is about 170 meters at the same depth . These radii are proportional to the cube roots of both the yield of the explosion and the inverse of its depth.

At high frequencies, amplitudes of the radiated P waves of explosions decrease as the inverse square of the frequency. The frequency at which the amplitude versus frequency curve changes from the low frequency slope of zero to the high frequency slope is called the corner frequency. This parameter is a function of all of the same parameters that effect low frequency amplitudes. The corner frequency of a fully decoupled one kiloton explosion is 50 Hertz (50 cycles per second), and the corner frequency varies inversely as the radius to elastic behavior. Thus, the corner frequency for a one kiloton tamped explosion is about 5 Hertz and that for a one kiloton explosion in a hole of 33 meter radius is 25 Hertz. The above relationships are all that are required to construct the suite of source spectral curves for explosions shown on Figure 1. Since the corner frequency of a fully decoupled one kiloton explosion is about 10 times higher than that of a tamped one kiloton explosion, the ratio of high frequency amplitudes is 1/10 rather than 1/200 as at low frequencies. This decreased decoupling at high frequencies, combined with the very low levels of seismic noise at high frequencies, allows detection of low yield fully decoupled nuclear explosions.

Since a simple explosion closely approximates a uniform pressure applied to a spherical boundary, such an explosion radiates neither shear nor Love waves. Rayleigh waves, being a complex phenomenon inherently linked to generation of P waves (and certain S waves), are a component of the waves generated by any explosion. The amplitudes of the radiated P and Rayleigh waves of a simple explosion are the same in all directions, i. e., the radiation patterns are radially symmetric.

Characteristics of Seismic Waves of Earthquakes and Actual Explosions

Earthquakes derive their radiated energy from a totally different source. Planet Earth is in a state of continuous deformation with resultant accumulation of stress and strain. The presence of such stresses can be easily confirmed by measurements in both seismic and aseismic areas. The processes and phenomena driving such deformation are the earth's heterogeneous structure, the strong gravity field of the earth, and the relatively rapid rotation of the earth. Convection within the mantle of the earth is of relatively little importance as a direct generator of strain, such convection serving primarily as a device for maintaining heterogeneity and thus as an essential element in maintaining operation of the other factors, even after 5 billion years of earth history.

An earthquake occurs when a weak zone (fault) in the earth impulsively fails under the state of accumulated strain, this failure being associated with freeing of the two sides of the fault from each other and rapid movement of these two sides to new positions of elastic equilibrium. This rapid movement engenders release of previously stored elastic strain energy as radiated elastic waves. This process of readjustment of strain in response to fault failure is termed "relaxation". As an analogue, consider the case where one elastically bends or "pre-stresses" the tines of a fork. If the tines are impulsively released, they return to their original unstrained state. In the process, elastic waves are generated which are felt by the hand holding the fork. If the fork is released slowly, no elastic waves are radiated. In the earth, such things as slow earthquakes occur, the radiations of such earthquakes being strongly deficient in high frequency waves. If release is sufficiently slow ("creep events" of seismologists), no radiated waves are detected.

Since the movement of the two adjacent fault blocks is constrained to be rectilinear past each other, and since the accumulated strain is always strongly anisotropic (different in different directions at the same point), the radiated elastic waves of an earthquake are much more complex than those of the simple explosion described above. There is no radial symmetry in the radiation pattern of any wave type as there was for both the P and Rayleigh waves of the simple explosion. Amplitudes are a strong function of direction from the source (i. e., asymmetric), the actual pattern being a diagnostic function of the type of fault movement that occurred. In addition, large amplitude S and Love waves are always generated, shear wave amplitudes at frequencies below the corner frequency being 5 to 10 times greater than P wave amplitudes. Like the P waves of explosions, the P and S waves of earthquakes are characterized by flat uniform amplitudes at low frequencies (the result of large volume relaxation), corner frequencies (linked to length of fault break and to velocity of rupture), and rapidly falling amplitudes as frequency increases above the corner frequency. The corner frequency phenomenon in earthquakes is much more complex than for explosions, largely because of variable rupture rates for earthquakes and the planar (rather than spherical) character of the failure surface. The result is that the shear waves of an earthquake have lower corner frequencies than the P waves of the same earthquake, while the P wave corner frequency of the earthquake is generally far lower than the P wave corner frequency of the explosion with the same level of low frequency P waves. The amplitudes of high frequency S waves decrease as the inverse first to second power of the frequency, while the high frequency P wave amplitudes of earthquakes decrease as the inverse second to third power of the frequency. These simple relationships are shown on Figure 2.

A more correct model of actual explosions can now be described. As is obvious from the discussion above, explosions actually occur in strained rocks rather than in unstrained rocks as assumed originally. The explosion creates a large volume of shattered or fractured rock. This large volume can no longer support strain. Thus, the surrounding mass of intact strained rock will change shape, readjusting strain and stress levels to accomodate to what amounts effectively to an instantaneously created very large hole. In this rapid readjustment, elastic waves are radiated. These waves, deriving as they do from the highly asymmetric state of strain of the earth, are of all potential types, most particularly including detectable amounts of Love waves and radially asymmetric Rayleigh waves.

Identification of the Seismic Waves of Explosions and Earthquakes

We can now comment upon the techniques available for identification of the seismic waves of explosions and earthquakes. The first screening involves determination of the depth at which each seismic event occurred, this depth being determinable by a variety of procedures based on measurements from seismograms. At least 90% of all earthquakes occur at depths greater than those at which explosions can be emplaced. Thus, a monitoring network maximizes its capability to determine depth of focus. The determination of an accurate depth of focus is not a requisite for identification of most earthquakes. It is only an effective procedure for rapidly identifying many earthquakes and thus decreasing markedly the population of seismic signals requiring further analysis.

No useful qualitative spectral criteria (existence versus non-existence of certain wave types) exist, the reason being the nearly universal release of previously stored strain by explosions and thus the association of Love waves and radially asymmetric Rayleigh waves with essentially all explosion signals. However, powerful quantitative discriminants do exist. One that has been extensively investigated is comparison of average amplitudes of one second P waves and twenty second Rayleigh waves (m_b versus M_S in the jargon of seismology). The factors leading to the existence of this discriminant are the high amplitude S waves of earthquakes (these S waves being the major source of the high amplitude surface waves of earthquakes) versus the near-zero S wave amplitudes of explosions, and the asymmetric radiation pattern of P waves of earthquakes versus the symmetric pattern of explosions. Theoretical analysis predicts exactly the separation observationally found between m_b versus M_S values of earthquakes and explosions, earthquakes having larger M_S values than do explosions of the same m_b. The values of this discriminant for earthquakes are nearly independent of depth of focus if less than 50 kilometers, a depth easily established by routine analysis. Quantitative separation of all earthquake and explosion signals for events of intermediate and larger size can be achieved by a criterion incorporating only depth of focus and the ratio of amplitudes of P and Rayleigh waves, confirming the predictions of seismological theory. The limits on use of this discriminant are established by ambient levels of 20 second atmospherically-induced seismic noise. At the amplitude levels generated by decoupled one kiloton explosions, detection of long period Rayleigh (or Love) waves will be impossible by any feasible network. Emphasis will have to be placed on detection of short period seismic waves. Thus, identification of small seismic events must be based on establishment of depth of focus and on the detailed spectral characterisitics of Figures 1 and 2, i. e., relative levels of P and S waves and amplitude as a function of frequency in the P waves of explosions and earthquakes. The fact that theoretically predicted spectral discriminants based upon the short period P waves of earthquakes and explosions do in fact exist has been documented by analysis of the data of many hundreds of earthquakes and many explosions. Calibration for source region and propagation path must be made but these are easily done.

There are two aspects of use of such discriminants that require mention. First, their effective use at small magnitude requires detection at distances of a few hundred kilometers of frequencies of as high as 30 Hertz. Do P waves of such frequency propagate to the requisite distances in terrains such as most of the USSR? Data in hand for regions that are geophysically analogous to most of the USSR (eastern USA) demonstrate that the answer to the above question can be made in the affirmative. Are such waves detectable in the presence of ambient levels of microseismic high frequency noise? Available data of various types establish that signal to noise ratios of at least 70 and 2.75 will occur at frequencies of 30 Hertz at distances of 300 and 1000 kilometers, respectively, from one kiloton fully decoupled explosions at carefully selected recording sites. Such signal to noise ratios are greater than required to achieve detection and identification. Therefore, the answer to the second question is also in the affirmative.

Proposed Problems with Implementation of the Above-noted Differences

If there are no other problems, an adequately large network (about 25 stations within the USSR plus 15 or so surrounding the USSR, it being understood that a complementary network will be deployed within the USA) can quite easily monitor a treaty set at a one kiloton limit. What other technical problems might exist?

A problem severely limiting early estimates of attainable monitoring capability was the potential for deliberate use of the P waves of large distant earthquakes as a "noise" in which to hide the short period waves of decoupled explosions (up to 10 kilotons or so), this problem existing even when using a network of many internal stations. This potential for deliberate cheating existed because detection of P waves was presumed to take place at one second period. P wave source amplitudes at one second period differ by a factor of 100,000 between magnitude 6.5 and magnitude 1.5 events. Even long distances of propagation would leave the P waves of a distant magnitude 6.5 earthquake far above those of a nearby magnitude 1.5 event. However, the source amplitudes of 30 Hertz P waves are nearly equal for earthquakes of these two magnitudes and the 30 Hertz amplitudes of a fully decoupled explosion typically are higher. There are factors that can increase the earthquake amplitudes by a factor of 5 or so but these only make explosion and earthquake source amplitudes equal. Long distance propagation of the earthquake signals will make them far smaller than those of a nearby explosion. Therefore, shifting of attention of a monitoring network to frequencies of 20 Hertz and higher totally eliminates this otherwise severe hiding-in-an-earthquake problem.

Previous analyses, even when considering only normal levels of seismic noise, had to struggle with the problem of fully decoupled explosions, expending much effort on arguing the feasibility or infeasibility of building air-filled cavities sufficiently large to fully decouple a several kiloton explosion. With the shift of attention to frequencies of 20 Hertz and higher, attainable signal to noise ratios by feasible networks become so large even for one kiloton fully decoupled explosions that all discussions of feasibility of cavity construction become passé. Even if the requisite cavity is built, the signal of a fully decoupled multi-kiloton explosion will be detected and identified by a feasible network.

A perturbation on use of a spherical cavity to reduce signal amplitudes is use of a highly asymmetric cavity to either further reduce high frequency amplitudes in selected directions (towards monitoring stations) or to generate waves sufficiently complex to confuse the monitoring network. Both old and recent analyses cast doubt on the efficacy of this scheme. Both analyses investigated the use of long essentially cylindrical cavities having volumes equal to that for full decoupling in spherical cavities. Both reached results which appear to demonstrate the uselessness of this configuration when considering decoupling of low yield explosions.

CTBT or TTBT?

A parameter requiring specification in a test ban treaty is the threshold level of monitoring capability required. This threshold has never been officially stated but a rational answer would be constrained by the following considerations: (1) development of strategic nuclear weapons, even when assuming high levels of scaling via previous knowledge, requires tests in the 5 to 10 kiloton range; (2) the specified level must be enforceable but must not create the basis for interminable irrelevant arguments; and (3) the specified level must not create an asymmetry in potential risk.

The first condition requires a monitoring network that quantitatively deters efforts at clandestine testing in the 5 to 10 kiloton range. The network mentioned above can easily attain a significantly greater capability. The last two conditions are linked. A concern expressed by the weapon laboratories is that the US would sign an unenforceable treaty (CTBT) and create a potential asymmetry. The idea is that we would observe the letter of the treaty with the result that our weapon laboratories would lose key personnel (the essential imaginative core of competence) as they drifted away to stimulating research in other scientific fields. A determined adversary might, however, maintain laboratory integrity by a campaign of low yield tests below the detection threshold of the monitoring network. After the treaty had been in force for, say, 10 years, he could abbrogate the treaty for some real or imaginary reason and then have a great advantage in weapon design for the years that it took us to reconstitute our laboratories. This potential risk argues for a LTTBT, not a CTBT.

A second aspect of the second condition is that seismologists know of no certain way to discriminate the seismic waves of a several ton tamped explosion from those of a low yield fully decoupled nuclear explosion. Thus, even given a capability to detect and identify as an explosion the signal of a sub-kiloton fully decoupled nuclear explosion, one could not distinguish it from the plethora of small industrial explosions taking place frequently within such a country as the USSR. Placement of the treaty threshold too far below that required for security purposes would lead only to endless confrontation over irrelevancies.

Based upon the seismological conclusions given earlier and the constraints on a test ban treaty posed above, it would appear that a one kiloton threshold treaty would be nearly ideal. It would prevent all tests of relevance to strategic weapons. The difference between treaty threshold and capability required for security purposes is so great (six tenths of a magnitude or greater) that any confusion about a yield near the threshold would not come close to contravening actual national requirements of the treaty. In the other direction, a fully decoupled one kiloton explosion generates a signal comparable to that of a 5 ton tamped explosion. Most industrial explosions are below this level and those above are generally distributed charges designed to break and move rock. Thus NTM could clarify most of them. Maybe the occasional SSC meeting would be required to clarify particular events.

It would seem advisable to include in an LTTBT provisions that all permitted low yield tests must be conducted at a single site specified in the treaty and that decoupled explosions are forbidden. Placement of such provisions in the treaty does not guarantee compliance but greatly decreases the scope for argument and dispute on technical matters. It becomes necessary only to detect an off-site test of any sort or to detect efforts at decoupling in order to establish non-compliance. Also, such constraints require only detailed calibration of one site in each country, thus allowing rigidly controlled procedures for estimating yield of the permitted low yield explosions and removing potential sources of dispute.

If the oft-stated thesis of Noel Gayler and others that there is no potential military use for theatre nuclear weapons is true, an LTTBT at one kiloton threshold effectively would constitute a CTBT. Thus, seismologists have successfully created the technical environment in which the cessation of nuclear testing can be achieved.

Postscript: Have the Soviets Cheated on the YTTBT?

A few comments on the still simmering dispute about the yields of several Soviet explosions of recent years may be of interest. Recent meetings of a panel convened by the Defense Advanced Research Projects Agency heard and new analysis that confirmed data published over ten years ago, data which established the existence of an 0.4 or greater difference in m_b values for explosions of equivalent yield in similar material at Nevada Test Site (NTS) and Semipalatinsk (STS) in the USSR, STS explosions having the greater m_b values. It may be of interest to point out that regional variation of several distinct geophysical parameters (mean elevation, velocity of P and S waves just below the Moho, depth to the Moho, heat flow from the interior of the earth, travel time of P and S waves through the upper mantle and crust of the earth, amplitudes of S waves, velocity versus period for Rayleigh waves, presence or absence of low velocity zone for P waves in the upper mantle, etc.) show an excellent and physically understood correlation with amplitude bias effects in P waves. Thus, seismological conclusions about the level of m_b bias between NTS and STS are well based and solidly established. The data establishing all of these correlations and the pertinent discussions noting the correlations with P wave amplitudes have been available for many years. All efforts to confuse this issue have been narrowly based and massively wrong.

A peculiar argument that purports to support the case for Soviet cheating on the Yield Threshold Treaty goes as follows. It is obvious from seismological observations that yields at STS have increased by a large factor since the YTTBT went into force. After the treaty went into force, the Soviets either were soon testing far above permitted yields or the US had badly over-estimated yields of Soviet explosions for many years. As a matter of long-demonstrated seismological fact, the latter situation was the case. The open seismological literature contained all of the relevant quantitative data proving this point. After elaborate discussion in the US government, it was concluded that the old analyses were indeed proof of magnitude bias. However, for some obscure reason, it was decided to adopt a bias value one-half of that implied by the seismological data. Yields of Soviet explosions were thenceforward estimated as if there were an 0.2 m_b bias between NTS and STS. During this time, the Soviets were increasing the yields of explosions at STS. One immediate US suspicion was that the Soviets had penetrated US security, had ascertained our adoption of an 0.2 bias, and were increasing yields up to that equivalent to the excessive magnitude level that the US had incorrectly accepted as equivalent to yields of 150 kilotons. A slightly different twist on this argument goes as follows. If the Soviets are now testing at only 150 kilotons at STS, they must have had a very low limit prior to the YTTBT, a time when there was no treaty-imposed limit. It is supposedly obvious that they would have been testing to 150 kilotons at STS prior to the YTTBT. Therefore, they must now be testing over the limit.

All of this argument takes place in spite of the fact that there is no known or suggested reason why the Soviets had been testing as high as 150 kilotons at STS at any time prior to the YTTBT. It was well known that the Soviets did all of their high yield testing at Novaya Zemlya, but the discussion of their post-treaty behavior at STS ignored their pre- and post-treaty behavior at Novaya Zemlya. As a matter of fact, the Soviets increased yields at STS to the point that magnitude values increased by much more than 0.2, thus making it clear that the reasons for increasing magnitudes had nothing to do with adoption of an 0.2 m_b bias by the US. In fact, they increased yields up to the point where an m_b bias of 0.4 was required to explain the large yield explosions as being 150 kilotons.

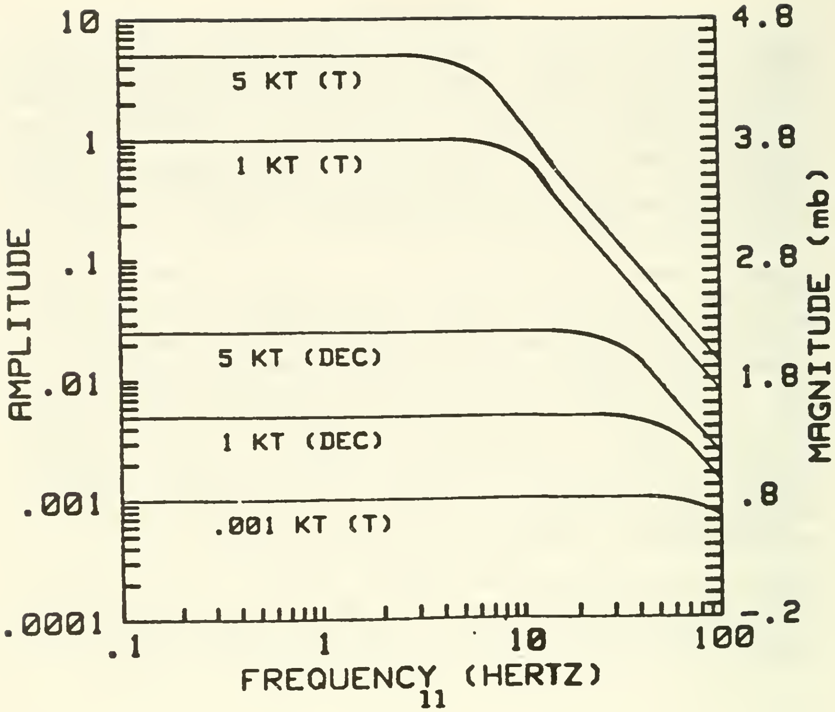
A look at the actual pattern of Soviet testing between 1971 and 1982 (Figure 3) plus a little seismological knowledge not known to the proponents of the arguments above probably explains what happened. The magnitude versus yield relationship on Figure 3 is that established and used by me since 1969 and published in the open literature in 1971. The m_b values of Soviet tests come from the Bulletins of the International Seismological Centre, the definitive source of routine types of seismological data (a better source than the preliminary data published by the US Geological Survey). The figure shows that between mid-1973 and late 1977, the Soviets limited yields at STS to about 50 kilotons while testing from 250 kilotons to 3 megatons at Novaya Zemlya. Subsequent to their agreement to abide by the conditions of the YTTBT, all testing at Novaya Zemlya ceased and maximum yields at STS gradually rose from 50 to 150 kilotons by mid-1980, remaining at that level ever since. Therefore, failure to test to 150 kilotons at STS prior to the YTTBT did not mean that high yield testing was not occurring. It was, but at Novaya Zemlya. The question then is why did the Soviets impose a 50 kiloton limit on testing at Semipalatinsk from 1974 to the time of the YTTBT and why did they increase yields at that site subsequent to the YTTBT. Research on the correlation of levels of ground motion, size of explosion or earthquake, and region of the world demonstrates that rates of attenuation of seismic energy are much less around STS (similar to eastern US) than around NTS. In fact, a one megaton explosion at NTS creates a comparable level of ground motion in Las Vegas as does a 50-75 kiloton explosion at STS in the nearby city of Semipalatinsk. The US conducted its underground multi-megaton test in the Aleutian Islands in order to prevent unacceptable levels of shaking in Las Vegas and Reno. Similarly, the Soviets did their high yield tests at Novaya Zemlya in order to protect Semipalatinsk. They had conducted 100 kiloton tests in 1973-1974 at STS. So, when the YTTBT came into force, they apparently decided to largely abandon the northern test site in favor of their much more developed test facility at STS while accepting higher levels of shaking in the city of Semipalatinsk.

Figure Captions

Figure 1 Source spectral curves (amplitude versus frequency) for the compressional (P) waves of tamped (T) and decoupled (DEC) explosions. Note the marked increase of corner frequency with decoupling and the much smaller vertical separation of the curves for tamped and decoupled explosions of the same yield at high frequencies than at low frequencies, indicating decreased decoupling at high frequencies. Also, note that the spectrum of a small tamped explosion (1 ton or .001 kiloton) is predicted to be indistinguishable from that of a 200 ton (.02 kiloton) decoupled explosion.

Figure 2 P spectra of explosions and the P and S spectra of earthquakes having the same level of P signal at low frequencies as the explosions. The two cases shown are for one kiloton both tamped (upper set of curves) and decoupled (lower set of curves). Solid lines are for P waves of explosions, dash-dot-dot for P waves of earthquakes, and dashed for S waves of earthquakes. Note the greater high frequency content of the P waves of the explosions and the fact that the predicted amplitude at 30 Hertz of a magnitude 1.0 earthquake is as great as that of all larger earthquakes, while the amplitude at one Hertz is orders of magnitude smaller than that of large earthquakes. The discrimination capability predicted at a frequency of a few Hertz for magnitude 4.0 events has been observed for Soviet explosions and Eurasian earthquakes in general and earthquakes near the Soviet test sites in particular.

Figure 3 Yield and magnitude of Soviet explosions at Semipalatinsk and Novaya Zemlya from 1971 to 1982. Note the cessation of all explosions with magnitudes above 6.2 in 1976. An explosion of 150 kilotons at Semipalatinsk is associated with a magnitude 6.2 seismic signal.


10
1
.1
.01
.001
.0001
AMPLITUDE
4.8
3.8
2.8
1.8
.8
-.2
MAGNITUDE (mb)
5 KT (T)
1 KT (T)
5 KT (DEC)
1 KT (DEC)
.001 KT (T)
.1
1
10
100
FREQUENCY (HERTZ)

11

Figure 2

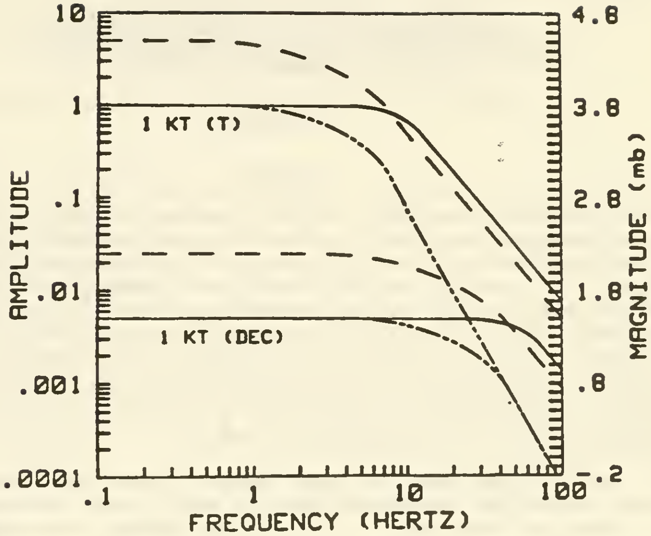
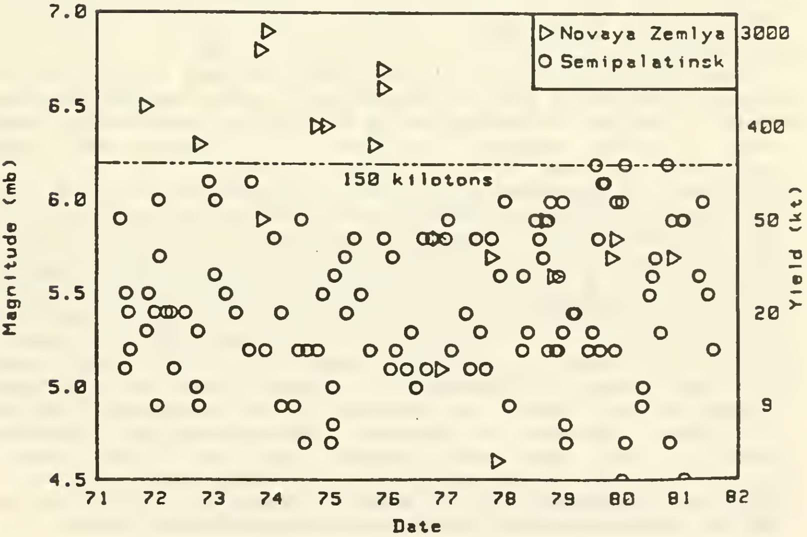


Figure 3



APPENDIX 7

MAY 1985 REPORT BY JACK F. EVERNDEN ENTITLED "AN EVALUATION OF SEISMIC DECOUPLING AND UNDERGROUND NUCLEAR TEST MONITORING USING HIGH FREQUENCY SEISMIC DATA"

AN EVALUATION OF SEISMIC DECOUPLING AND UNDERGROUND NUCLEAR TEST MONITORING USING HIGH FREQUENCY SEISMIC DATA

J. F. Evernden*, C. B. Archambeau**, and E. Cranswick*

(May 1985)

Abstract

An effective solution to the problem of the detection and identification of low yield coupled and fully decoupled underground nuclear explosions is available via use of high frequency seismic data ranging up to 30 to 40 Hertz. In order to illustrate the detection-identification capabilities available when using such data, it is necessary that we discuss: (1) seismic recording system noise at high frequencies; (2) ground noise characteristics over the seismic band 5-40 Hertz; (3) signal transmission characteristics over this band through pertinent types of earth structure; and (4) spectral characteristics and relative amplitudes of both P and S waves from explosions and earthquakes over the same frequency band.

In this study, each of these topics is considered in turn as they relate to detection and discrimination of the signals of low yield coupled and decoupled explosions by use of data obtained in the regional and teleseismic distance ranges. These discussions are followed by estimates of the capabilities of specific hypothetical networks to detect and identify (in so far as signal-to-noise ratio is an important factor in identification) explosions within the USSR. These estimates of signal detection capability provide the central focus for the study as they serve to translate diverse and rather complex sets of observational data and theory into concrete predictions of monitoring capability. Following the assessment of detection capabilities, the problem of identification of small events is considered, with particular emphasis on discrimination at those distances where the network is calculated to provide signals of high signal-to-noise ratio, i. e. at regional distances.

The principal results and conclusions of this study are; (1) seismic system noise can be suppressed to levels well below ground noise at quiet sites at frequencies at least as high as 30-40 Hertz when using presently available hardware; (2) average microseismic displacement amplitude levels, at carefully selected sites, vary as $f^{-\xi}$ with increasing frequency where $\xi \cong 2\text{-}2.5$. Such sites are easily found by diligent search and occur in a number of geological environments; (3) transmission of high frequency P and S wave signals in the regional distance range in terrains of major interest is nearly as efficient as at 1 Hertz, effective Q factors in shield areas being about 9000 and 4000 for P_n and S_n, respectively. The effective Q for P waves in tectonic areas is about 1000; (4) a network of 25 simple non-array stations internal to the USSR and 15 similar stations surrounding the USSR is predicted to be capable of detecting on a multi-station basis at high signal-to-noise ratio fully decoupled explosions of 1 kiloton located at all potential decoupling sites within the USSR; (5) by inference from the quantitative agreement of empirical observations and theoretical predictions when using lower frequency data over a great range of explosion yields, we calculate that procedures based on use of predictably detectable P and S waves will serve to identify events as small as those expected of fully decoupled one kiloton explosions.

APPENDIX 8

REPORT BY JACK F. EVERNDEN ENTITLED "WHY HAS IT BEEN IMPOSSIBLE TO ARRANGE A CTBT?"

Why Has It Been Impossible to Arrange a CTBT?

Jack F. Evernden*

Ladies and gentlemen, I beg your forgiveness for the contents of this paper if they turn out to be other than what you expected. I have struggled for many years to convince the politicians and citizens of this country of the technical feasibility of a Comprehensive Test Ban Treaty (CTBT) or a Low Threshold Test Ban Treaty (LTTBT), but I have seen that technical feasibility either not appreciated or, more commonly, negated by totally non-technical factors. Though I once did, I no longer believe that technical considerations have anything to do with negotiation and attainment of new test ban treaties. Therefore, I will not spend my time today reciting a litany of seismological lore. Rather, I will express my deeply felt views on why no progress towards such treaties has occurred in the past two decades. I hope that you will find these views at least thought-provoking. Be it understood that "CTBT" and "LTTBT" can be used interchangeably in all that follows. For a variety of reasons which I have stated elsewhere, I strongly favor negotiation of a LTTBT with the threshold near 1 kiloton rather than negotiation of a CTBT.

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[[Only seismology provides the capability to detect and identify underground explosions at long range and to estimate their yields. I have been involved in research on these topics since January 1965. I left the faculty at the University of California at that time to go to Washington and work on these problems. I felt then as I do now that it is of transcendent importance to the US and to the world to create the technical environment which will allow negotiation of a treaty eliminating all nuclear testing.]]

I must begin by saying that the experience of watching a small segment of seismology raised to such import that Presidents, Secretaries of State, Premiers, Foreign Ministers and Ambassadors hold forth eloquently on their understandings or misunderstandings of the subject has been both interesting and amusing. However, observing them make politically motivated assertions having little resemblance to the relevant science has been disallusioning. And, to see them direct national policy purportedly based on whether seismologists can or cannot identify the seismic waves of earthquakes and explosions at some arbitrarily selected small magnitude level rather than basing policy on the enormity of the potential catastrophe if nuclear weaponry is not contained has been frightening indeed.

Let me make it perfectly clear that our understanding of the similarities and differences between the seismic waves of earthquakes and underground explosions is for, all practical purposes, complete.

Even if one once believed that technical considerations were of ruling importance relative to attainment of a Comprehensive Test Ban Treaty (CTBT) or a Low Threshold Test Ban Treaty (LTTBT), that belief can no longer be held. Technical understanding of the seismological aspects of monitoring such treaties is now essentially complete and we know that a low threshold treaty can be successfully monitored. We know how to detect the signals of small explosions, we know how to identify those signals as having derived from explosions rather than earthquakes, and we know how to establish the yields of those explosions within factors of uncertainty so small as to be of no significance to meaningful monitoring[1]. A sampling of pertinent articles by myself and co-authors is included in the distributed version of this talk. The problem relative to negotiation of new test ban treaties today is lack of political will, not technical incompetence.

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[1] L. R. Sykes and J. F. Evernden, "The Verification of a Comprehensive Nuclear Test Ban", Scientific American (October 1982), pp. 47-55

J. F. Evernden and C. B. Archambeau, "Seismological Aspects of Monitoring a Comprehensive Test Ban Treaty", Chapter 19 in "Technical Means of Verification of Compliance with Arms Control Treaties", Pergamon/Brasseys (1985, in press).

J. F. Evernden, C. B. Archambeau, E. Cranswick, "An Evaluation of Seismic Decoupling and Underground Nuclear Test Monitoring Using High Frequency Seismic Data", in process of publication, pre-print available upon request.

J. F. Evernden, "Several Aspects of Various Test Ban Treaties", prepared for distribution here, attached.

The route to this present technical capability has had some tragic twists and turns. Simple qualitative discrimination criteria proposed by seismologists in the late 1950's failed badly because of unforeseen complexities in the deforming ball upon which we live. The demonstration of the failure of these criteria without presentation of alternatives was a major factor in impelling President John Kennedy to negotiate a Limited Test Ban Treaty (LTBT) rather than a Comprehensive Test Ban Treaty (CTBT), the LTBT having banned nuclear testing in all environments except underground. Tragically, data adequate to demonstrate the validity of the currently used criteria for identifying underground nuclear explosions were available for analysis prior to Kennedy's decision. In fact, the first massive demonstrations of the validity of the most important of these criteria, though taking place after ratification of the treaty, were based upon data which pre-dated the treaty. Lack of either scientific perception or purpose denied the world the one and only real chance it has yet had for negotiation of a treaty banning all nuclear explosions.

One must face the fact that nearly all US administrations since the invention of the bomb, whether Democratic or Republican, have, despite assertions of support for a verifiable CTBT, consistently portrayed verification capabilities to be so inadequate that the political advantages of a CTBT to the world in general and the US in particular were outweighted by the risks associated with potential cheating by the Soviets. With the presently widely known capabilities of verification techniques, continued statement of that position is difficult to comprehend.

Indeed, one must seriously question whether there ever has been support for a CTBT within the US government since the presidency of John Kennedy. During the last two decades of nearly continuous negotiations on a CTBT by the multi-national Conference of the Committee on Disarmament (CCD) in Geneva, there has been a clear understanding by both political and technical personnel of the US delegations that the intent of our participation was to thwart any progress on a CTBT by that body. [[From Chairman Lewis Strauss of the Atomic Energy Commission protesting a test cessation as a "very fateful step"[2] to more recent testimony before the Subcommittee on Intelligence and Military Application of Nuclear Energy of the House Armed Services Committee that concern over "stockpile aging" and "modification of warheads for new military requirements", plus attrition of skilled designers, militate against a test ban[3],]] US governmental policy nearly always has been opposed to a CTBT. At one CCD session I attended in Geneva in the early 1970's, where sophisticated technical discussions took place and the outside world (if it noticed at all) might have assumed some progress to be imminent, it became apparent that the entire session was arranged and held for the sole purpose of improving an ambassador's standing in his home country. It was to me a bitter experience to realize that the entire machinery of an international body such as this could be prostituted to such narrow and trivial purpose while ignoring the enormous problem it supposedly had convened to discuss.

[2,3] A. Greb & W. Heckrotte, "The Long History: The Test Ban Debate", Bulletin of the Atomic Scientists (Aug/Sept 1983), p. 37 and p. 40.

In the mid-1960's, while employed by the Department of Defense, I was asked to advise on the technical content of a letter written for the signatures of the Joint Chiefs, this letter stating that all of the earlier words of the Chiefs in support of a verifiable comprehensive test ban treaty were false. It had just been convincingly demonstrated for the first time that there were indeed seismological techniques that could distinguish the seismic waves of explosions and earthquakes and there was every reason to believe that these techniques would work for smaller events than had as yet been investigated. This demonstration prompted the Chiefs to state flatly that they never had been in favor of a CTBT. They had been willing to assert they were only as long as seismologists were incapable of monitoring such a treaty, thus providing the Chiefs with a convenient shield behind which to hide their real attitudes. Upon removal of that shield, they stated the truth that they were then and would remain opposed to a CTBT. They would always opt for bombs rather than for mutual forbearance, under the millenia-old attitude that the only ways to deal with one's enemies are via the doubled fist and the truncheon, and unlimited license to build new engines of war.

Since giving technical advice for that letter, I have never been surprised when each subsequent advance in seismology has been deprecated by those high in the immediate US administration. Over the years, no matter what capability has been demonstrated, it has been declared to be inadequate. Thus, when it was asserted in Congressional testimony in the early 70's that a network acceptable in fundamental character to the Soviets could be built which would monitor Soviet behavior to 1 kiloton, this conclusion was not disputed by the

Defense Department. Instead, the Director of Defense Research and Engineering said that monitoring to a quarter of a kiloton would be required for national security! Since his statement, it has become common knowledge that a capability to confirm compliance at 5 to 10 kilotons is all that is required to insure national security in the area of strategic weaponry. Has placement of the critical threshold well above the monitorable threshold caused any positive movement by the U. S. Government (USG) relative to a CTBT? No. Have the oft-repeated statements by men such as Admiral Noel Gayler that there is no military use for theatre nuclear weapons had any impact on decision at high levels? Apparently not. The will to pursue a course of mutual forbearance nearly always has been overwhelmed by distrust and fear.

A requirement still placed on a CTBT by the USG is the need for numerous on-site inspections (OSI) under the condition that the location and timing of these within the USSR are to be picked by the US, the sole requirements of site selection being that a seismic event is detected at the specified locality and the resulting seismic waves are either confusing or indicative of an explosion by US analysis. The idea of OSI is old, originally having been proposed before the Kennedy era as a way around the inadequacies of seismology. The Soviets have to this day adamantly refused to agree to such inspections (for a brief interval, they agreed to 3 but the US then demanded more). During the past two decades, two important events occurred. First, seismologists learned how to do the monitoring job in a manner acceptable to the USSR[1]. Second, it was demonstrated in elaborate testimony to Congress by the Department of Defense in the early 1970's, based on extensive well-funded research, that there is no operationally feasible way to obtain useful information via OSI's even if the Soviets agreed to them. Thus a negotiable and adequate seismological capability had been found while a non-negotiable but always-demanded supposed inspection capability was shown to be non-existent. Did anything change? No. The most recent CTBT draft negotiated under President Carter still insisted on OSI. Originally proposed in a positive vein, insistence on OSI has become a major device for thwarting a CTBT. One cannot help but speculate that, if the Soviets ever agreed to them, OSI would be heard of no more. Lest it seem I view the US as having a monopoly on irrational response founded in distrust, I should add that from my perspective the Soviet refusal to accept OSI is a totally irrational act on their part. They see goblins where none exist and thus fail to comprehend what is really behind the US insistence on OSI.

The current presidential assertions that the Soviets have probably cheated on the Yield Threshold Test Ban Treaty (YTTBT) are based upon such an incredibly thin thread of seismological argument as to be unobservable even under high magnification. There are many tens of papers in the seismological literature which taken together quantitatively deny this presidential assertion and prove without a doubt that available seismological evidence does not support the case for Soviet cheating on the YTTBT. All of the necessary analysis has been in the hands of the USG for years. Why all of these efforts to obfuscate?

An explanation, a simple one, for all of this irrationality has become apparent to me after years of contending with these issues.

And it has nothing to do with one or all governments consciously harboring evil intent. No, the situation is far more dangerous than that. It's simply that when most men, whether liberal Democrat, conservative Republican or Soviet Communist, come to ultimate governmental authority, they are of no better stuff than you and I and they are oft overwhelmed by the responsibility and complexity of political decision, particularly when such decision must be made on the basis of scientific data that they totally fail to comprehend, data which are multi-dimensional and highly sophisticated and about which someone with a hidden agenda will always argue there is a dangerous margin of interpretation and possible uncertainty. [[There still are flat-earthers and there still are physicists who question predictions of Einstein's theories of relativity.]] When faced with being accountable through the ages to come for the safety of their respective countries during their few years of tenureship, should a President or Premier take the route of the untried or should he follow the oft-tried and oft-failed but always defensible and always strongly felt route of the mailed fist? He is certain that no one can accuse him of weakness if he opts for guns and bombs. Maybe stupidity, but not weakness. That such conduct actually is a sign of a much more profound weakness is a point too subtle for his anxious mind to comprehend. It took uncommon nerve and strength to see and act upon the greater vision granted John F. Kennedy.

This admininstration has striven harder than any other to convince the US public of the dangers of arms control treaties and of Soviet misbehavior, but it is only fair to point out that it was the Carter administration that, after achieving Soviet agreement to a remarkable draft of a CTBT in tri-lateral discussions (UK,US,USSR), aborted any further advance on such a treaty after being frightened by the unknown and thus imponderable threat that just maybe something might go wrong and the Soviets might gain some unspecifiable but none the less critical advantage via a CTBT. [[President Carter, according to Harold Agnew (then Director of Los Alamos National Laboratory), had had every intention of going ahead with a CTBT until Agnew and Roger Batzel (then Director of Livermore National Laboratory), spent a mere two hours talking to Carter and "turned him around"![4]]] Thus, as typical of nearly all men, President Carter in the end opted for Stealth bombers and MX missles rather than for a CTBT. Not being at all certain that I am better than they, I always feel a mixture of pity and anger for those who have served in high office, who were overwhelmed by it, who acquiesced in the elaborating nuclear insanity, and who lived long enough to realize the enormity of their misbehavior. Thus, President Eisenhower, after leaving office, finally realized and declared that his greatest mistake was not negotiating a CTBT. Presidents Ford and Carter, two men who totally failed to help the world towards cessation of nuclear testing when they had the power and opportunity to so help, recently have become vocal proponents of a Comprehensive Test Ban Treaty.

It is now clear that nearly all men in positions of responsibility will build yet another generation of nuclear warheads rather than make any move towards nuclear restraint.[[As Richard Garwin has stated, "time after time our national security choices have been misdirected by false argument, concealed assumptions and hidden agendas, and .... some of the best options have been ruthlessly suppressed".[5]]] The problem exists equally in all nations and for the same reasons. Why then do I believe that leaders always opt for guns rather than rational accomodation, even under the threat of nuclear holocaust? Because each of them is one of us and all of us are participating in the psycho-drama of the intelligent ape, a creature who, like all other animals, uses his genetic specialization in the service of his psychological makeup. In our case, this is a makeup that was vital for survival only a few thousand years ago, but a makeup that today may lead to self-destruction unless controlled. Until we deeply comprehend that we are just another animal doing what animals do, there is little hope. Unless we find the strength to establish mastery of our intellect over our outmoded and presently dangerous patterns of emotional response, only the abyss awaits. We need not change human nature, we need only recognize it as the problem and then control and dominate it.

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[4] Interview with Harold Agnew in the Los Alamos Science Magazine, (Summer/Fall 1981), p. 154.

Unfortunately, feelings of revulsion or horror about a world devastated by nuclear explosions are not sufficient basis for effective action leading to elimination of such a possibility. Man's dogmas have so ordered his priorities that many would opt for destroying the world rather than seriously seeking accomodation and understanding of other societies. What is required is recognition and acceptance of our basic oneness and unity, notwithstanding apparent differences designed by our psychological makeup to obscure that oneness and unity.

Both our society and that of the Soviets teach gross untruths about the other to their citizens, with the result that totally invalid feelings of animosity are developed. Whether such teaching is done through ignorance, fear or malice, its result is dangerous misunderstanding. Opinion polls show that Americans do not trust Soviets. Why not? Because their government has told them that the Soviets cannot be trusted and the American press has parroted those condemnations, all of this without the American public being supplied with documented examples of Soviet dishonesty. Only prejudicial interpretations, no compelling facts.

Soviet officialdom, on the other hand, has taught the Soviet people total untruths about the status of the individual in American society. Soviet leaders may even believe some of these untruths. No one can presume that things are perfect in the USA but they certainly are not as taught to Soviet citizens. However, I do not believe that the deliberate lies of Soviet and American officialdom are in either case the lies of evil men. They are rather the lies of frightened and dogma-ridden men striving to maintain their strength of resistance against forces they deem evil and dangerous to their survival. Each government would probably destroy all rather than yield dominance to the great evil it perceives itself to be facing.

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[5] R. Garwin, "Who proposes, who disposes, who pays?", Bulletin of the Atomic Scientists (Jun/Jul 1983), p.11.

What then must we learn if we are to save ourselves? We must deeply sense and understand that most of the elaborate and intricately constructed dogmas within which we enfold ourselves and our actions and on the basis of which we justify our animosities, fears and greeds relative to others are simply intellectual constructs deliberately designed to give conscious credibility to our emotional responses, responses shared in many essential details with most other animals, and responses which are incredibly dangerous in the context of the technologic world our intellect has fashioned. We must learn that our differences arise out of mutual fear and mutual isolation, out of historical processes which have so colored and warped the perceptions of all of us that we accept utter nonsense as revealed truth. We must sense our innate trivialness as we whirl through limitless space and time on this insignificant scrap of rock, a scrap separated by at least 40 trillion kilometers from any other animate life. We must cease thinking as Greeks, Romans, Celts, and Muscovites were allowed to think in possibly more barbarous but certainly safer times when man's power to destroy was finite. We must cease making moralistic decisions about other cultures, becoming aware that such decisions are not absolute but are culture-conditioned. We must recognize that we have been programmed to conceive as evil that which we in our fears deem dangerous to our survival. We must understand that it is this widely held irrational fear of the "other" that poses the greatest threat to our survival. For the sake of ourselves and our children, we and the Soviets must strive to approach each other through accommodation and understanding rather than through confrontation and misunderstanding.

Can we really recognize that our problems are ourselves and not the other race, the other culture, the other religion? I hope so. The time grows late but I still pray that our collective assertion of control will win the struggle and that my little corner of science will be allowed to play its clear and useful role in helping us all escape the ultimate insanity of nuclear war.

Finally, I shall have the audacity to read a short poem by Robinson Jeffers. Though I have spent my career as a scientist, my views of man's steps along the path of scientific understanding and exploitation are very similar to those expressed by him in "Science":

Man, introverted man, having crossed
In passage and but a little with the nature of things this
  latter century
Has begot giants; but being taken up
Like a maniac with self-love and inward conflicts cannot
  manage his hybrids.
Being used to deal with edgeless dreams,
Now he's bred knives on nature turns them also inward:
  they have thirsty points though.
His mind forebodes his own destruction;
Actaeon who saw the goddess naked among the leaves and his
  hounds tore him.
A little knowledge, a pebble from the shingle,
A drop from the oceans; who would have dreamed this
  infinitely little too much?

Robinson Jeffers

APPENDIX 9

SYNOPSIS OF FEBRUARY 1975 REPORT BY JACK F. EVERNDEN ENTITLED "REGIONAL BIAS IN MAGNITUDE VERSUS YIELD MEASUREMENTS: ITS EXPLANATION AND MODES OF EVALUATION"

Regional Bias in Magnitude versus Yield Measurements: Its Explanation and Modes of Evaluation

Jack F. Evernden
(February 1977)

Synopsis (May 1985)

This report was written in 1976/77 for submission to the Arms Control and Disarmament Agency at the time of inter-agency discussions relative to the reality of and value of the magnitude bias in m_b and M_S between Nevada Test Site (NTS) and Semipalatinsk and Novaya Zemlya (SP/NZ). The problem, of course, was the coming into force of the YTTBT and the need to calibrate the observed magnitudes of Soviet explosions at SP/NZ relative to those at NTS so that the NTS magnitude versus yield curves could be used for estimation of the yields of Soviet explosions.

The report demonstrated the multiple procedures for estimating those biases (zero bias for M_S values; 0.4-0.45 bias for m_b values, the m_b values at SP/NZ being greater than those at NTS for explosions of the same yield), the physical bases for that bias structure, and the indisputable fact that the problem had been solved since 1971. It was shown via many references to the published literature that there was, as of 1977, total understanding of the bias problem.

The only thing that has happened since 1977 is that several new investigators have become interested in the problem, have re-conducted old modes of analysis using more recent data, have either published in the unclassified literature or submitted reports in governmental channels, and have confirmed in fine detail the results presented in 1977.

All confusion in later years has arisen because the inter-agency panel in 1977 made the bureaucratic decision to accept the reality of regional bias in m_b, but decreed an m_b bias value only half that actually operative (0.2 instead of 0.4-0.45) while totally ignoring the data on M_S values. Why they followed such scientifically unsupportable procedures is beyond my comprehension. Ever since, government seismologists have had to live with this decreed but incorrect bias, thus being forced to report incorrect estimates of yields of Soviet explosions (too high by a factor of about 2).

APPENDIX 10

March 1985 Paper by Lynn R. Sykes Entitled "Verification of a Comprehensive Test Ban Treaty, Soviet Compliance With the Threshold Test Ban Treaty and Testing of Nuclear Weapons"

Presented at Round Table Discussion on
Nuclear Testing and the Comprehensive Test Ban
Washington, D.C.
March 8, 1985

VERIFICATION OF A COMPREHENSIVE TEST BAN TREATY, SOVIET COMPLIANCE WITH THE THRESHOLD TEST BAN TREATY AND TESTING OF NUCLEAR WEAPONS

Lynn R. Sykes
Higgins Professor of Geological Sciences
Lamont-Doherty Geological Observatory of Columbia University
Palisades, New York 10964

Introduction and Major Conclusions

I am addressing you today as a scientist who has been involved in research related to verification of nuclear test ban treaties for the past 24 years. I was a member of the U.S. delegation that negotiated the Threshold Test Ban Treaty with the Soviet Union in 1974. I have been a member of several U.S. Government panels that have examined questions of verification of atomic testing. Seismology, my main field of expertise, provides the main tools for verification of a Comprehensive Test Ban and for ascertaining if the Soviet Union has detonated explosions above the 150 kiloton limit of the Threshold Treaty.

It my presentation I would like to make the following major points:

1. A Comprehensive Test Ban Treaty is verifiable with high reliabilty down to explosions of very small size. Recent advances in seismology ensure that clandestine cheating will be even easier to detect than was thought only two years ago.

2. There is a growing preponderance of scientific opinion that the Soviet Union has not violated the 150 kt limit of the Threshold Test Ban Treaty. Both the USSR and the United States have tested repeatedly near the limit since the treaty took effect in 1976.
3. The main impediments to a Comprehensive Test Ban Treaty are not scientific or technical but rest on the notion that U.S. security is best enhanced by continued testing and development of new atomic weapons.
4. A Comprehensive Test Ban Treaty or a very low yield threshold treaty with a limit of about 1 kt would put an end to the testing of a so-called third generation of new atomic weapons like the x-ray laser.

Verification of a Comprehensive Test Ban Treaty

A Comprehensive Test Ban Treaty is one of the longest running items on the arms control agenda. Active interest in it now goes back more than 30 years. Most seismologists who have been involved in test ban research, like myself, believe that the main technical and scientific impediments to verifying a comprehensive treaty were solved by 1968. Since that time the capability to detect small explosions and to identify or discriminate their signals from those of small earthquakes has improved steadily. The United States has spent about one-half a billion dollars in this area over the past 25 years; more than a billion dollars has been spent worldwide.

Extensive negotiations towards a comprehensive treaty were conducted among the United States, the United Kingdom and the Soviet

Union from 1977 to 1980. All of the long-contested aspects of verifying such a treaty were resolved, at least in principal, by 1980 including a moratorium on the testing of peaceful explosions, provisions for U.S. seismic monitoring posts within the USSR, international exchange of seismological data and on-site inspections of the challenge type. Those negotiations have been in abeyance since 1980.

Enough experience has been accumulate in operating arrays of seismic detectors so there is no longer serious disagreement that explosions of 0.1 to 0.2 kt in hard rock would be detected and identified with high confidence. Those sizes of explosions are, of course, well below the yields of weapons deployed on strategic systems and well below the 5 to 10 kt limit cited in unclassifed congressional testimony a few years ago as the size of weapons testing that would be of military significance.

There is greater disagreement among experts about the sizes of weapons that might go undetected if the Soviet Union tries its best to cheat by detonating explosions in ways that would muffle their seismic waves. All seismologists involved in this problem conclude that the most serious evasion possibility is that of detonating explosions in large cavities - the so-called Big Hole or decoupling theory. Scientists from the weapons laboratory usually assume that Big Hole decoupling will work near the maximum theoretical limit and that such attempts to cheat will not be verified by satellite surveillance.

I think that Big Hole evasion has been seriously overrated for a number of reasons. The volume of rock that must be excavated to fully decouple an explosion of about 8 kt is equivalent to the volume of the largest Egyptian pyramid, a fact that pessimists usually forget to tell you. Experience with the one atomic explosion that the U.S. detonated to test this idea and theory both indicate that muffling is not as strong at high frequencies. In the last two years it has been recognized that high frequencies seismic waves propagate readily across large parts of the Soviet Union. Using a high-frequency capability and with seismic monitoring posts in the Soviet Union, it is possible to verify even the most strenuous attempts to cheat at a level of 1 kt and larger.

It is clear that arguments will continue to be put forth that the testing of very tiny nuclear explosions would be of significant military advantage, whether that is case or not. Thus, a serious alternative to a Comprehensive Test Ban Treaty would be a very low yield threshold treaty with an agreed upon limit of about 1 kt.

Compliance with the Threshold Test Ban Treaty

Allegations that the Soviet Union has violated the Threshold Test Ban Treaty by testing above the 150 kt limit have formed a critical component of the case now being made by the United States Government that the Soviets have cheated repeatedly on arms control agreements. Two years ago this was described as definite cheating. In the statement released by the White House on February 1 that allegation has now been reduced to a "likely violation". That change in language has, I believe, resulted from strenuous objections by the seismological community over the past two years.

I and many others have long argued that the United States Government is not using the correct formula for converting the sizes of seismic waves generated by Soviet explosions into yields. It is now universally accepted that the correct methodology for estimating yields must take into account the geological and geophysical properties of the upper 100 miles of the earth directly beneath various testing areas. All of the main Soviet testing areas are on old geological terrains while the U.S. data come mainly from Nevada, a region of recent earth movements and volcanic activity. If these differences are not accounted for correctly, the estimated yields of USSR tests are too large. Several years ago the U.S. Government moved in the direction we advocated. Nevertheless, they did not move far enough and the methodology still leads to serious over-estimates of the sizes of Soviet explosions. For too long we have seen an obsession with trying to justify the largest possible yields that cannot be absolutely refuted rather than adopting a formula that gives the most likely estimate of yield.

Two of us organized a major symposium for the American Geophysical Union almost two years ago. About 500 people heard presentations on whether the Soviet Union was likely to have cheated on the Threshold Treaty and how well a Comprehensive Test Ban could be verified. About 15 experts presented their findings. Only two of them, scientists from the Defense Advanced Research Projects Agency (DARPA), believed the Soviet Union had cheated on the Threshold Treaty. There was a strong consensus among the participating experts, those attending the symposium and in press coverage of the symposium that the USSR had not cheated. This was indeed surprising since most of the scientific experts receive major funding from DARPA. Other U.S. Government agencies, scientists from the Lawrence Livermore

Weapons Laboratory and scientists from the United Kingdom and Sweden also do not think the Soviet Union has cheated.

Need for an Independent Review

As I outlined above, there is a heavy weight of scientific opinion in the United States, in several U.S. Government agencies and among knowledgable scientists abroad that the Soviet Union has not cheated on the Threshold Treaty and that the United States has been using an incorrect formulation for estimating yield. Here is a classical case where bureacratic infighting and the opinions of a few have dominated policy. There is a strong need for an independent review of scientific and technical capabilities for the verification of the Threshold Treaty and a Comprehensive Test Ban Treaty. I recommend that the Congress ask the U.S. National Academy of Sciences to conduct such a review. Another possibility would be a major review by the Office of Technological Assessment. It must be remembered that the weapons laboratories will strenuously object to a Comprehensive Test Ban Treaty as a threat to what they see as their essence and reason for being. Major hearings by Congress on these matters are long overdue.

Patterns of Atomic Testing by the USSR

The United States has paid a heavy price for following a methodology that overestimates yields of Soviet explosions and assigns those yields a large uncertainty. This price is twofold: 1) in the area of arms control agreements and 2) in intelligence about Soviet capabilities.

Figure 3 shows histograms of the numbers of explosions (vertical axis) of various sizes as a function of a measure of size, the short-period seismic magnitude m_b. Our best estimates of yields in kilotons are shown for the pronounced peaks in the histograms. There are many explosions of nearly the same yield, and most explosions are confined to a few pronounced peaks.

There is a very pronounced peak near 500 kt for tests at Novaya Zemlya for the period before the Threshold Treaty took effect in 1976. The peak at 500 kt probably represents the size of the weapon carried by the SS-18. Its yield is often assumed to be considerably larger. Overestimates of this type can lead to exaggerated estimates of the total megatonnage carried by Soviet ICBM's and to overestimates of the yield for a given weight. Thus, it is certainly not in the best interests of the United States to have the Soviet Union test lighter weapons of say 500 or 1000 kt. They have not done so since 1975. Ratifying the Threshold Test Ban Treaty would prevent them by treaty from doing so again.

Conclusions

1. The Soviet Union has not violated the 150 kt limit of the Threshold Treaty as alleged. It is in the best interests of the United States that the Soviet Union not test above the 150 kt limit.

2. A Comprehensive Test Ban Treaty can be verified down to explosions of very small size, about 1 kt. An alternative to a comprehensive treaty would be a low yield threshold treaty with a limitation of about 1 kt.
3. The major impediment to a Comprehensive Test Ban Treaty is the notation that the United States should continue testing new weapons to keep ahead of the Soviet Union. As in the past, the USSR can be expected to develop similar weapons a few years later, resulting in an increasingly dangerous world.

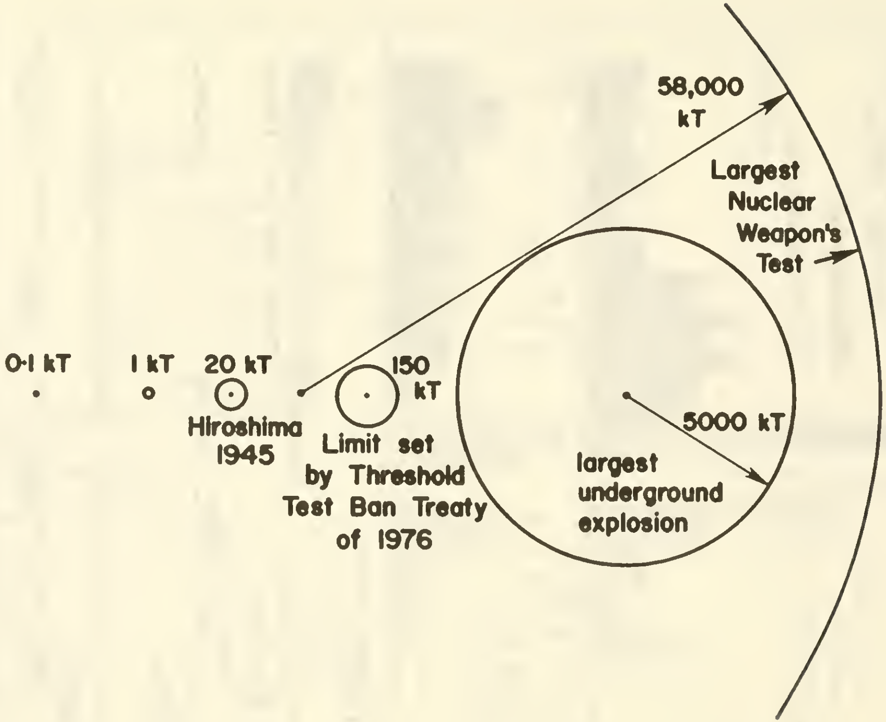
0·1 kT
1 kT
20 kT
Hiroshima 1945
150 kT
Limit set by Threshold Test Ban Treaty of 1976
5000 kT
largest underground explosion
58,000 kT
Largest Nuclear Weapon's Test

Figure 2. Weapons of various sizes that have been tested to date. The energy release of the largest underground explosion (about 5,000 kt) is equivalent to that of all the munitions expended in World War II. With U.S. monitoring posts in the Soviet Union a Comprehensive Test Ban Treaty or a low yield treaty could be verified for explosions of about 1 kt or larger. That size is much smaller than weapons emplaced on strategic systems today (about 40 to 10,000 kt) or the weapons that opened the Atomic Age in 1945.

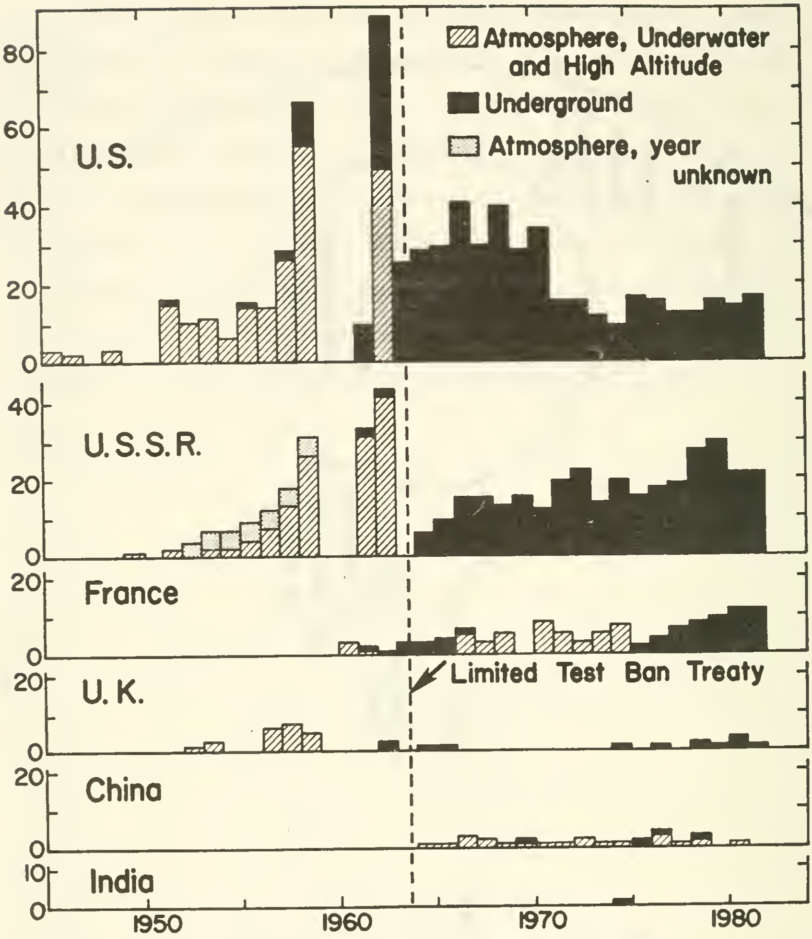

Figure 1. Number of explosions by six nuclear powers. Note that Limited Test Ban Treaty of 1963 did not put an end to atomic testing but merely drove testing underground by signatories to treaty.

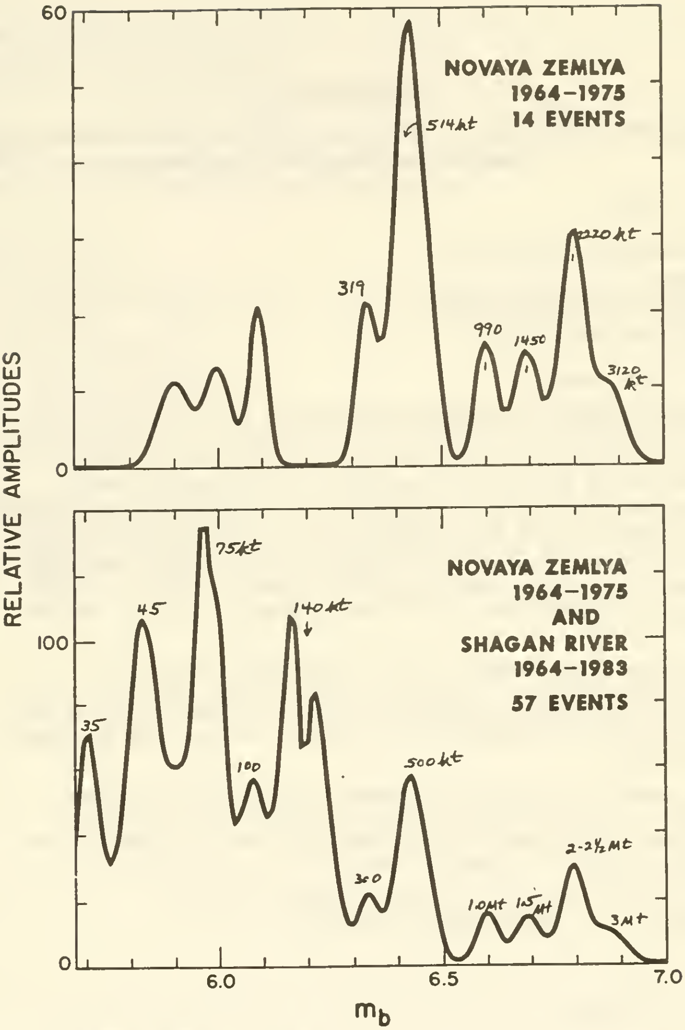

Figure 3. Histograms of number of explosions as a function of size (horizontal axis) at Soviet test sites at Novaya Zemlya and Shagan River (Central Asia). Note pronounced clustering of Soviet tests into a few peaks. Yields for major peaks are indicated.

APPENDIX 11

LETTER FROM SCIENTIFIC AND ARMS CONTROL EXPERTS TO CHAIRMAN FASCELL ON WEAPONS RELIABILITY

May 14, 1985

The Honorable Dante Fascell
Chairman
Committee on Foreign Affairs
U.S. House of Representatives
Washington, D.C. 20515

Dear Mr. Chairman,

Continued nuclear testing is not necessary in order to insure the reliability of the nuclear weapons in our stockpile. The best way to confirm reliability is to disassemble sample weapons and to subject the components to non-nuclear tests. Weapons can also be detonated without their nuclear components in order to insure that the complete assembly operates correctly. Nonexplosive tests are also available for determining whether the nuclear components have deteriorated during storage. If aging problems are found in some components, these components can be replaced with newly fabricated ones, using the original design specifications.

In the past these techniques have identified a number of reliability problems. In no case, however, was the discovery of a reliability problem dependent on a nuclear test and in no case would it have been necessary to conduct a nuclear test to remedy the problem.

In any event, it would be completely impractical to conduct the large number of nuclear tests that would be required to establish by this method a statistically meaningful measure of the reliability of stockpiled weapons.

We hope these observations will be useful to you in considering the Comprehensive Test Ban.

Sincerely,

Hans Bethe

Hans Bethe
Nobel Laureate in Physics
former Director, Theoretical Division, Los Alamos National Laboratories

Norris Bradbury
former Director, Los Alamos National Laboratories

Richard Garwin
IBM Fellow, Thomas J. Watson Research Center
Consultant, Department of Defense, Department of Energy

Spurgeon M. Keeny, Jr.

Spurgeon M. Keeny, Jr.
former Deputy Director, ACDA

Wolfgang K H Panofsky

Wolfgang Panofsky
former Director, Stanford Linear Accelerator

George Rathjens

George Rathjens
former Deputy Director, Defense Advanced Research Projects Agency (DARPA)

Herbert Scoville, Jr.

Herbert Scoville, Jr.,
former Deputy Director, CIA
former Technical Director, Defense Department Armed Forces Special Weapons Project

Paul C. Warnke

Paul Warnke,
former Director, ACDA

APPENDIX 12

LETTER FROM RICHARD GARWIN TO CHAIRMAN FASCELL CONCERNING HIS VIEWS ON THE NEED FOR A COMPREHENSIVE TEST BAN TREATY

Richard L. Garwin
IBM Thomas J. Watson Research Center
P.O. Box 218
Yorktown Heights, NY 10598
(914) 945-2555

March 4, 1985

RECEIVED
MAR 07 1985
COMMITTEE ON
FOREIGN AFFAIRS

The Honorable Dante B. Fascell
2354 Rayburn House Office Building,
Independence Avenue
between South Capitol Street
and First Street, SE
Washington, DC 20515

Dear Mr. Fascell:

Greenpeace asked me to participate in a briefing for Congress on the Comprehensive Test Ban Treaty (CTBT) for 03/08/85, but I am unfortunately unable to be there. I am taking the opportunity of writing you my views, however and making them available also to Eric Fersht of Greenpeace.

I believe that we can and should have a CTBT. The primary reason for a CTBT is to strengthen the barriers to proliferation of nuclear weapons. If the US and the Soviet Union are no longer testing nuclear weapons, the world will take seriously our commitment to eliminate the spread of nuclear weapons to any other country. This would require strong support by the Congress and by the Administration to use political and economical and all other available sanctions against the testing of nuclear weapons. This is also a primary reason why the US and the Soviet Union should greatly reduce their arsenals of nuclear weapons, at present unnecessarily large, and that the French, British, and Chinese should not build irrevocably their inventories beyond a few hundred.

Any treaty has to be defined in such a way that it can be complied with. That is a greater problem than verification. It should also be written in a fashion that compliance can be verified (or non-compliance be detected).

There are, of course, many details and problems with a CTBT. There is some nuclear explosive yield which cannot be detected-- perhaps 100 tons of TNT equivalent or even under certain circumstances 1 kiloton (KT). But the United States has much more to fear from Soviet explosions in the 130-KT range (which are totally unrestricted now, so long as they are conducted underground) than from some Soviet explosion

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Also Adjunct Professor of Physics at Columbia University
(Views not necessarily those of IBM or Columbia)

in the 0.5-KT range conducted occasionally and clandestinely in violation of a CTBT.

The idea that we must continue to have nuclear explosions to test third-generation nuclear weapons for the transition to a strategic posture based on defense rather than on deterrence is incompatible with the President's extremely strong commitment to a future in which the defense against possible nuclear weapons is non-nuclear. In fact, if those very capable individuals now supported by government funds and working on third-generation "defensive" nuclear weapons would work on non-nuclear defenses, presumably that effort would be strengthened and the President's goal attained sooner, if ever.

The last point often made against the acceptance of a CTBT is the matter of stockpile viability. I enclose the letter which I sent to President Carter in 1978, along with Doctors Norris E. Bradbury and Jay Carson Mark. I remain convinced that deterioration of weapons in stockpile can be determined by non-nuclear tests and the weapons remanufactured to be just as good as new. They will be no better than new, but new is good enough. I fully understand that there are many ways in which weapons could be improved by modifications to increase safety, improve yield, and the like. And I am aware that recent nuclear tests has demonstrated some of these possible improvements. But it continues true that the stockpile can be maintained reliable and viable for the uses we need to make of nuclear weapons without nuclear testing.

I believe that it is more important to US security to ban the test of nuclear explosives by the Soviet Union and the other nations of the world than to be able to continue our own testing.

There are proposals for use of very small nuclear explosions (perhaps 1 ton or less) to produce commercial nuclear power. It might therefore be said that one could not totally ban nuclear explosions, and there must always be a threshold below which explosions are permitted. I've already discussed the inadvisability of setting such a threshold high enough that any violation would certainly be detected. While that improves verifiability of the treaty, it would allow the Soviet Union to do more than it could do with a lower threshold and a treaty which (as a result) is less verifiable. Our ability to detect any significant explosion would be undiminished by the lower threshold, but it would introduce great difficulties for the Soviets in conducting these tests! One approach to a CTBT without an explicit threshold would be to ban all nuclear explosions except those which take place in permanent, above-ground, occupied buildings.

An exchange at a public meeting in Sicily between myself and Roger Batzel, Director of the Lawrence Livermore National Laboratory, was reported by Hugh DeWitt in, I believe, the

April 1984 issue of the *Bulletin of the Atomic Scientists.* The exchange is accurately reported, and DeWitt draws a fair interpretation that the nuclear stockpile could indeed be kept viable in the face of deterioration (by remanufacture) if only the laboratories had the ability to keep people from modifying the design and the process, with the argument of *de minimis.* But "many a mickle makes a muckle," and we just shouldn't allow any mickles or changes.

I hope this is of some use to you.

Sincerely yours,

Richard L. Garwin rsa

Richard L. Garwin

cc:
    Eric Fersht

RLG:rsa:063|DBF:030485.DBF

APPENDIX 13

LETTER FROM RICHARD GARWIN TO CHAIRMAN FASCELL CONCERNING WEAPONS RELIABILITY

Richard L. Garwin
IBM Thomas J. Watson Research Center
P.O. Box 218
Yorktown Heights, NY 10598
(914) 945-2555

May 3, 1985

The Honorable Dante B. Fascell
Chairman
House Foreign Affairs Committee
Attention: Ms. Janey Wright
2103 Rayburn House Office Building,
Washington, DC 20515

Dear Congressman Fascell:

One of the important concerns in regard to the desirability of a comprehensive test ban treaty (CTBT) is the degree to which the nuclear weapons in our stockpile will remain reliable, given the care which could properly be accorded under a CTBT. Nuclear tests of stockpile weapons would be precluded, but high-explosive tests and inspection of all kinds would be entirely in order, just as is the case at present.

In this regard, I want to call attention to the enclosed letter of August 15, 1978 to President Jimmy Carter, from Drs. Norris E. Bradbury, J. Carson Mark, and myself. In almost 7 years since that letter was written, I have reviewed this matter twice and have seen additional instances of problems in the development of nuclear weapons. Nevertheless, my judgment remains that expressed in the letter to President Carter-- that the effectiveness and viability of the stockpile can be maintained under a CTBT by techniques which are well understood.

To quote briefly from the attachment,

> "As you know, the assurance of continued operability of stockpiled nuclear weapons has in the past been achieved almost exclusively by non-nuclear testing-- by meticulous inspection and disassembly of the components of the nuclear weapons, including their firing and fuzing equipment. Problems encountered in this inspection are normally validated by additional sampling and solved by the remanufacture of the affected components. This program is, of course, supplemented by the instrumented firing of the entire nuclear weapon with inert material replacing the fissile materials, and the entire program thus far

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Also Adjunct Professor of Physics at Columbia University
(Views not necessarily those of IBM or Columbia)

> described would be unaffected by the requirements for a CTBT. It has been exceedingly rare for a weapon to be taken from the stockpile and fired 'for assurance'."

We answered specifically the question:

> "Can the continued operability of our stockpile of nuclear weapons be assured without future nuclear testing? That is, without attempting or allowing improvement in performance, reductions in maintenance cost, and the like, are there non-nuclear inspection and correction programs which will prevent the degradation of the reliability of stockpiled weapons?"

Then we stated and countered several arguments that are normally made, including the suggestion that under a CTBT a president, or congress or the Department of Energy might not provide funds for stockpile maintenance inspection and correction, or that a president might not provide a requested exemption from OSHA or EPA requirements. We saw

> "no reason to assume that the national security bureaucracy will not continue to serve the national interests, and we would welcome a statement in conjunction with a CTBT that non-nuclear testing, inspection, and remanufacture where necessary will be fully supported in order to ensure the continued operability of stockpile nuclear weapons."

Recognizing that there are some useful things that can be done by nuclear testing (although it is not necessary for maintaining the reliability of the existing stockpile), I nevertheless strongly support a CTBT. I do this to reduce the threat of emergence of Soviet advances in the field of fission and fusion weapons, but especially to provide that leadership in the world which is so necessary for a firm and effective campaign against the proliferation of nuclear weapons to additional states. President Reagan has recognized that nuclear weapons are not weapons in the usual sense of the word-- that nuclear war cannot be won and must not be fought. Nevertheless, he does not propose to eliminate our deterrent force until something suitable can be found to replace it, and neither do I. Yet our security interests are decidedly not served by the spread of nuclear weapons to additional nations.

I see no contradiction in basing our security for the foreseeable future on deterrence by threat of nuclear retaliation, on the one hand, and supporting a total ban on nuclear explosions on the other.

A proper judgment as to the value and acceptability of a CTBT cannot be obtained by looking at our own nuclear weapons program alone-- obviously! One must include the benefits to the US from the absence of testing of nuclear weapons by our adversaries and by strengthening the consensus against proliferation of nuclear weapons.

Sincerely yours,

Richard L. Garwin

Richard L. Garwin

Encl:
  08/15/78 Letter by Richard L. Garwin, Norris E. Bradbury, and J. Carson Mark to President Carter regarding nuclear weapons stockpile reliability under a Comprehensive Test Ban Treaty (published in the Congressional Record 08/16?/78). (081578LGBC)

RLG:rsa:123|DBF:050385.DBF

August 15, 1978

President Jimmy Carter
The White House
Washington, D.C. 20500

Dear Mr. President:

As individuals long involved in the conception, design, manufacture, test, and maintenance of many of the United States' nuclear and thermonuclear weapons, we want you to know of our judgment on a question which has assumed considerable prominence in connection with the Comprehensive Test Ban Treaty ("CTBT"). That is the question of the degree of assurance in the continued operability of our stockpiled nuclear weapons in the absence of any possibility of testing with significant nuclear yield (for instance, with testing limited to laboratory-type experiments.)

As you know, the assurance of continued operability of stockpiled nuclear weapons has in the past been achieved almost exclusively by non-nuclear testing--by meticulous inspection and disassembly of the components of the nuclear weapons, including their firing and fuzing equipment. Problems encountered in this inspection are normally validated by additional sampling and solved by the remanufacture of the affected components. This program is, of course, supplemented by the instrumented firing of the entire nuclear weapon with inert material replacing the fissile materials, and the entire program thus far described would be unaffected by the requirements of a CTBT. It has been exceedingly rare for a weapon to be taken from stockpile and fired "for assurance."

It has also been rare to the point of non-existence for a problem revealed by the sampling and inspection program to require a nuclear test for its resolution. There are three acceptable approaches to the correction of deficiencies without requiring nuclear testing:

1) Remanufacture to precisely the original specifications.

2) Remanufacture with minor modifications in surface treatment, protective coatings, and the like, after thorough review by experienced and knowledgeable individuals.

3) Replace the nuclear explosive by one which has previously been tested and accepted for stockpile.

A fourth option, to replace the troubled nuclear system by one not already prooftested may result in improved performance, lesser use of special nuclear materials, or the like, virtues which have more to do with improvement of the stockpile than with confirming its operability.

We believe that the key question to be answered by those responsible for making and maintaining nuclear weapons is

> "Can the continued operability of our stockpile of nuclear weapons be assured without future nuclear testing? That is, without attempting or allowing improvement in performance, reductions in maintenance cost, and the like, are there non-nuclear inspection and correction programs which will prevent the degradation of the reliability of stockpiled weapons?"

Our answer is "yes," and we now discuss the reasons why knowledgeable people may have answered "no" to seemingly similar questions.

First, we confined ourselves essentially to the question, "If the stockpile is not required to improve, can it be kept from degrading?" Others may have had in mind the normal work of the weapons laboratories, by which nuclear weapons are continuously made somewhat more efficient, less costly in terms of nuclear materials, adapted to new packaging requirements, and safer to handle--for instance by the substitution of insensitive explosive. We have participated in such programs and find them both interesting and useful. Were these "improvement programs" carried out long enough without nuclear testing, the weapons thus affected would indeed have uncertain performance; the solution under a CTBT would be to forego such programs in order not to sacrifice stockpile reliability to a desire for minor improvement in performance.

Second, it is true that certain deficiencies have in the past been corrected by the replacement of the affected nuclear system by another one, following a test certifying the replacement model as ready for stockpile. This corrective measure would not be available under a CTBT. But the examples normally cited need not have been corrected in this way; for instance one Polaris warhead problem could readily have been solved by remanufacture with an acceptable change of surface treatment on the component which had caused the problem. The change of nuclear system was not absolutely necessary for the correction of the problem observed.

Finally, it is sometimes claimed that remanufacture may become impossible because of increasingly severe restrictions by EPA or OSHA to protect the environment of the worker. We note that additional protective measures which might be an intolerable cost burden in the manufacture of cardboard or of lightbulbs or of aircraft brakes are easily affordable in connection with the nuclear stockpile. Thus if the worker's environment acceptable until now for the use of asbestos, spray adhesives, or beryllium should be forbidden by OSHA regulations, those few workers needed to continue operations with such material could wear plastic-film suits (supplied with external air) commonly used for isolation against germs and against certain pharmaceuticals. It would be wise also to stockpile in appropriate storage facilities certain commercial materials used in weapons manufacture which might in the future disappear from the commercial scene.

It has been suggested that under a CTBT a President or Congress or the Department of Energy might not provide funds for stockpile maintenance inspection and correction, or that a President might not provide a requested exemption from OSHA or EPA requirements. We see no reason to assume that the national security bureaucracy will not continue to serve the national interest, and we would welcome a statement in conjunction with a CTBT that non-nuclear testing, inspection, and remanufacture where necessary will be fully supported in order to ensure the continued operability of stockpiled nuclear weapons.

We believe that the Department of Energy, through its contractors and laboratories, can through the measures described provide continuing assurance for as long as may be desired of the operability of the nuclear weapons stockpile. We are making this statement available to others in the Executive and the Congress.

Sincerely Yours,

Norris E Bradbury
Norris E. Bradbury

J. Carson Mark
J. Carson Mark

Richard L Garwin
Richard L. Garwin

BIOGRAPHIES

Norris Bradbury was the immediate successor to Robert Oppenheimer when, in 1945, Dr. Bradbury became Director of the Los Alamos scientific laboratory and served in that capacity for a quarter of a century until 1970. A physicist and member of the National Academy of Sciences, Dr. Bradbury was also Professor of Physics at the University of California during this period and is a recipient of the Legion of Merit and of the Fermi Award.

Richard Garwin has been a consultant to the Los Alamos Laboratory for almost three decades, since 1950, and is highly regarded in the national security community for his in-depth technical analyses of an extremely broad range of defense issues. A physicist and member of both the National Academy of Sciences and the National Academy of Engineering, he has served as a member of the President's Science Advisory Committee, as a member of the Defense Science Board and as a consultant to the Arms Control and Disarmament Agency, among other agencies.

J. Carson Mark was head of the Theoretical Division of the Los Alamos Scientific Laboratory from 1947 to 1973. This Division was responsible for, and played a key role in, the conception and design of U.S. nuclear and thermonuclear weapons in the fifties and sixties. He continues to be involved in considerations of weapons effects and with the problem of the maintenance of a nuclear weapons capability under nuclear test limitations.

Phone numbers at which the signatories can be reached are —

Bradbury: 505-662-5068
Garwin: 914-945-2555
Mark: 505-667-7612

APPENDIX 14

STATEMENT FROM WOMEN STRIKE FOR PEACE IN SUPPORT OF H.J. RES. 3

Women Strike for Peace
201 MASS. AVE., N.E., WASHINGTON, D.C. 20002
Area Code 202 - 543-2660

Twenty four years ago Women Strike for Peace began as a women's protest against nuclear testing in the atmosphere. We were one of the forces that led to the ratification of the Limited Test Ban Treaty in 1963.

In the early 1960's we learned that exposure to radioactive strontium-90 and Iodine-135, even in small amounts, could cause cancer of the bones and the thyroid in children. Since then there has been massive proof of the damage to life from radiation. It has been established that leukimia rates among people living in parts of Utah downwind of the Nevada test site (due to venting of underground tests) are 40% higher than that of the general population. The U.S. veterans who were exposed to radiation from atomic tests are still suffering from a variety of cancers and genetic damage to their children.

Today, we and our children are faced with a far greater danger: the threat to life itself posed by the unprecedented ever more destructive nuclear weapons of the United States and the Soviet Union. We believe the continued development of more sophisticated nuclear weapons through ongoing testing greatly increases the risk of nuclear war.

The Comprehensive Test Ban Treaty is the longest unresolved business vital to the security of our country and the world. President Kennedy's Limited Test Ban Treaty pledged signers "to achieve the discontinuance of all test explosions of nuclear weapons for all time and to continue negotiations to this end." This commitment is yet to be fulfilled. The Comprehensive Test Ban Treaty has been the major foreign policy goal of at least six U.S. Administrations and of the United Nations. Congress must make sure it is the goal of the present Administration as well.

A ban on all nuclear explosions is the unfinished goal of Women Strike for Peace. A Comprehensive Test Ban Treaty would curtail the race for more sophisticated and more deadly weapons and would be a major step toward the prevention of nuclear war. H.J. Res. 3 is a significant move in this direction.

APPENDIX 15

STATEMENT FROM DR. CHARLES B. ARCHAMBEAU, UNIVERSITY OF COLORADO, IN SUPPORT OF H.J. RES. 3

April 30, 1985

Hon. Dante Fascell
Chairman, House Foreign Affairs Committee
2103 Rayburn Bldg.
Washington, D.C. 20515

Dear Mr. Fascell:

I wish to extend my support in favor of a resolution asking the administration to submit the Threshold Test Ban Treaty to congress for ratification and, further, I strongly support its ratification by congress. The basis for my support for these actions stems from my firm belief that the treaty is verifiable and in the best long term interests of the United States. Further, I feel that such a treaty can lead to a uniform reduction in nuclear weapons development world-wide and to additional related arms control agreements reducing the possibility of nuclear war.

A key issue relating to the treaty has been whether compliance with its provisions can be verified, in particular whether the limitation to underground tests of 150 kilo-tons and less can be verified independently by signators of the treaty in order to insure that a dangerous imbalance in weapons development cannot occur. My professional knowledge in this matter leads me to conclude that we have the capability to verify compliance with the 150 kilo-ton test limit by seismic methods and that our confidence in these methods and their accuracy is now such that there is no reasonable likelyhood that tests within the USSR significantly above the 150 kt. limit could occur without our knowledge.

In this context, significantly above 150 kt. means tests with yields exceeding the threshold by 30% or more. Further, with the exchange of test site data that would be part of the treaty agreement, it is quite possible that uncertainties now limiting the accuracy of yield estimates of tests at USSR sites could be reduced somewhat.

Since I do not have the necessary information to confidently judge whether relatively small increases in yields above 150 kt. would provide an advantage in weapons development, I cannot be sure that there would not be some temptation on the part of the USSR to take advantage of the relatively small uncertainty associated with seismic estimates of yields and to test somewhat above the threshold. However, I am quite sure that repeated violations of this sort would carry an ever increasing risk of confirmation of the entire series as violations. Therefore, while such "small" violations are possible, given the current seismic analysis capabilities, I do not believe that a meaningful test program involving a series of such tests could be carried out without discovery. I also suspect, but do not know with certainty, that any such small increase over the 150 kt. threshold would be of little or no importance in weapons development.

Certainly the wisdom of signing this treaty with the USSR is, to some degree at least, dependent on their past performance with regard to adherence to the 1976 agreement to limit testing below 150 kilo-tons. I am aware of several statements of concern voiced by numerous U.S. government officials, including the President, as to Soviet compliance with this provisional agreement. However, it is quite clear, I believe, that the scientific evidence strongly favors the conclusion that no systematic program of testing over the 150 kilo-ton limit has been carried on by the Soviets, and further that it is highly probable that the largest yield tests observed were all at, or quite close, to the 150 kilo-ton limit. In this regard, there is now wide agreement among most, if not all research scientists who are knowledgeable in this area, that past estimates of the larger Soviet yield tests were over-estimates due to differences between our own test sites in Nevada, which were used as control models for estimating yields in general, and the Soviet test sites. Specifically, on the basis of many studies carried out over the last several years we have been able to conclusively show that differences exist between the Soviet site conditions and other test sites, in particular the Nevada test site, and we have been able to quantify these differences. With these results, in which we have considerable confidence, we have been able to recompute the Soviet yields from the observed seismic data and we obtain results that provide no basis for any charge of violations of the 150 kilo-ton limit. Indeed, when similarly refined seismic methods are applied to our own tests, the resulting yield estimates for our program since 1976 are similar to those for the Soviet program.

Since it is now quite apparent that the test threshold has been observed by all parties, and that future compliance can be verified with relatively small uncertainty, it appears appropriate and advantageous that the treaty be ratified.

If I can be of any aid to the committee, or if some amplification of these remarks is required, I would be happy to be of assistance.

Sincerely yours,

Charles Archambeau

Dr. Charles B. Archambeau
Professor of Geophysics
University of Colorado
Boulder, CO

APPENDIX 16

LETTER FROM DR. LYNN SYKES, LAMONT-DOHERTY GEOLOGICAL OBSERVATORY, IN SUPPORT OF H.J. RES. 3

mont-Doherty Geological Observatory | *Palisades, N.Y. 10964*
Columbia University

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Palisades New York State
TWX-710-576-2653

Telephone: Code 914, 359-2900

26 April 1985

Honorable Dante Fascell
Chairman House Foreign Affairs Committee
2103 Rayburn Office Bldg.
Washington, D.C. 20515

Dear Representative Fascell;

I am writing to you as a scientist who has been involved with the verification of Nuclear testing for the past 24 years. I would like to give you my views about the verifiability of the Threshold Test Ban Treaty (TTBT) and the Peaceful Nuclear Explosions Treaty (PNET) as your committee begins consideration of HJ RES 3.

In this letter I would like to make the following points:

(1) Both the Threshold Treaty and the Peaceful Explosions Treaty can be verified with high confidence.

(2) There is strong scientific evidence that the Soviet Union has not violated the 150 kiloton limit of the TTBT. Both the U.S.S.R. and United States have tested repeatedly near that limit since the treaty took effect in 1976. The USSR has not violated the PNET.

(3) The TTBT and the PNET call for extensive exchanges of data when the treaties are ratified. Those provisions would considerably enhance the verification capabilities of the United States.

(4) Thus, it is in the best interest of the United States that the Soviet Union not test very large weapons. Ratifying the TTBT would constrain the USSR by treaty from conducting large tests. In the absence of such a restraint, the U.S.S.R. would probably have an asymmetrical advantage in that it could conduct very large tests much easier than the United States.

(5) A Comprehensive Test Ban Treaty is verifiable with high reliability down to explosions of very small size. Recent advances in seismology insure that clandestine cheating will be even easier to detect than was thought only two years ago.

I was a member of the U.S. Delegation that negotiated the TTBT with the Soviet Union in 1974. I have been a member of several U.S. Government panels that have examined questions of verification of atomic testing. I am presently a member of a scientific panel for the Department of Defense that examines methodology for estimating the yields of Soviet explosions. Seismology, my main field of expertise, provides the main tools for verification of a Comprehensive Test Ban and for ascertaining if the Soviet Union has detonated explosions above the 150 kiloton limit of the Threshold Treaty.

USSR Compliance with the TTBT

United States' capabilities for estimating yields of Soviet explosions (and hence verifying compliance with the 150 kiloton limit) have improved dramatically over the past several years. Two of us organized a major symposium for the American Geophysical Union two years ago. About 500 people heard presentations on whether the Soviet Union was likely to have cheated on the TTBT and how well a Comprehensive Test Ban could be verified. About 15 experts presented their findings. There was a strong consensus among the participating experts, among those attending the symposium and in press coverage that the U.S.S.R. had not cheated. Scientists from the Lawrence Livermore Weapons Laboratory and scientists from the United Kingdom and Sweden who have done extensive work on seismological verification also did not think the Soviet Union has cheated.

It is now universally accepted that the correct methodology for estimating yields must take into account the geological and geophysical properties of the rocks at test sites and of the upper 100 miles of the earth directly beneath various testing areas. All of the main Soviet testing areas are on old geological terranes while U.S. data come mainly from Nevada, a region of recent earth movements and volcanic activity. If these differences are not accounted for correctly, the estimated yields of U.S.S.R. tests are too large. I and many others have long argued that the United States Government is not using the correct formula for converting the sizes of seismic waves generated by Soviet explosions into yields. The allegations that the U.S.S.R. has violated the TTBT are based, in my estimation and that of many seismologists, on an incorrect calibration formula. When the correct methodology is used, it is evident that the Soviet Union has not cheated on the Threshold Treaty. It, like the United States, has conducted many tests since 1976 close to the 150 kiloton limit.

On April 5 the seismic review panel of the Defense Advanced Research Projects Agency of which I am a member submitted a classified report on the estimation of yield. The recommendations of that panel, if they are implemented, should go far in clearing up these allegations. In addition the U.S.S.R. has complied with the PNET by not detonating peaceful explosions above 150 kilotons.

Verification Measures Following Ratification of Treaties

The PNET and TTBT both have extensive provisions for verification. Upon ratification the TTBT calls for the exchange of data on geological and geophysical properties of testing areas, for tests to be conducted at specific sites and for data to be released on the sizes of calibration explosions. Those provisions will permit the United States to estimate yields of Soviet tests more accurately. It is known that the sizes of the seismic waves detected from explosions vary with the nature of the rock near the explosion point. The provisions of the TTBT were particularly aimed at giving a better calibration of that geological factor.

It should be pointed out that the United States can already estimate yields with high confidence. When the correct methodology is used, it is evident that the yields provided thus far by the Soviet Union for four of their peaceful explosions are correct and that they have not given us incorrect or misleading information.

The PNET also has extensive verification procedures including the first language allowing on-site inspections by U.S. personnel within the U.S.S.R.. That provision could be extremely important in future arms control agreements such as a Comprehensive Test Ban Treaty.

Disadvantages to United States Security by not Restraining Soviet Testing

Relatively little attention has been focused on the disadvantages that are likely to follow if the 150 kiloton limit on the testing of nuclear weapons is not continued. Both the United States and the Soviet Union have had to conduct their very largest underground tests at very remote sites away from their main testing areas in Nevada and Central Asia, respectively. Prior to the TTBT the U.S. conducted its largest tests at Amchitka in the Aleutian Islands while the U.S.S.R. conducted their largest tests at their Arctic test site at Novaya Zemlya. The U.S.S.R. has continued to conduct some small tests at their Arctic test site in conformance with the terms of the TTBT while the United States has tested at Nevada but not at Amchitka. We could not conduct very large tests at Nevada without incurring damage in Las Vegas and possibly in Reno. Thus, in the absence of an agreement between the U.S. and U.S.S.R. not to conduct very large tests, the U.S.S.R. could resume the testing of weapons larger than one megaton relatively easily while the United States could not do so very quickly or easily.

The TTBT and PNET also provide a means for the U.S. to maintain its technological lead in nuclear weapons. My estimates indicate that weapons that were tested by the U.S.S.R. in the period just before the TTBT went into effect in 1976 and were placed on Soviet strategic systems in the following few years have lower yield-to-weight ratios than those for comparable American systems. Thus, it is certainly not in the best interests for the United States to have the Soviet Union conduct weapons' testing to full yield of lighter-weight weapons of say 500, 1,000, or 2,000 kilotons. They have not conducted tests of those sizes since 1975. Ratifying the Threshold Treaty would prevent them by treaty from doing so again.

Verification of a Comprehensive Test Ban Treaty

A Comprehensive Test Ban Treaty (CTBT) is one of the longest running items in the arms control agenda. Active interest in it now goes back more than 30 years. Most seismologists who have been involved in test ban research, like myself, believe that the main technical and scientific impediments to verifying a CTBT were solved by 1968. Since that time the capability to detect small explosions and to identify or discriminate their signals from those of small earthquakes has improved steadily.

Extensive negotiations towards a comprehensive treaty were conducted among the United States, the United Kingdom and the Soviet Union from 1977 to 1980. All of the long-contested aspects of verifying such a treaty were resolved at least in principal by 1980 including a moratorium on the testing of peaceful explosions, provisions for U.S. seismic monitoring posts within the U.S.S.R., international exchange of seismic data and on-site inspections of the challenge type. Those negotiations have been in abeyance since 1980.

I conclude that a CTBT can be verified down to explosions of very small size, about 1 kiloton, if the United States has seismic listening posts within the U.S.S.R. (as was agreed to in the negotiations from 1977 to 1980). An alternative to a CTBT would be a low-yield threshold treaty with a limitation of about 1 kiloton.

Conclusion

In summary, let me state that the threshold and peaceful explosions treaties are verifiable with a high degree of confidence. Both treaties call for extensive verification procedures including the exchange upon ratification of data that will permit more accurate verification. There is a growing preponderance of scientific opinion that the Soviet Union has not violated the TTBT. It is in the best interests of the United States that the Soviet Union not test very large nuclear weapons. Hence, it is very much in the best interests of the United States that we ratify both treaties.

Sincerely yours,

Lynn R. Sykes

Lynn R. Sykes
Higgins Professor of Geological
Sciences

LRS/rb
Encs.

APPENDIX 17

Letter From Willard Hannon, Lawrence Livermore National Laboratory, Expressing His Views on the CTBT, PNET, and TTBT

Lawrence Livermore National Laboratory

April 29, 1985

The Honorable Dante B. Fascell
Chairman, Subcommittee on Arms Control,
International Security and Science
House Committee on Foreign Affairs
2103 Rayburn Building
Washington, D. C. 20515

Dear Sir:

In response to your request, this letter provides my views on the verifiability of the Threshold Test Ban Treaty (TTBT) and the Peaceful Nuclear Explosion Treaty (PNET). In this response I have considered a treaty verifiable if I believe that we can identify militarily significant violations of the treaty in time to mount an appropriate response.

1) Question: Have the Soviets exceeded the 150 kiloton limit under the TTBT? If so, is it a militarily significant violation?

Answer: The current assessments of the relationships among yield, seismic magnitude, and the pattern of Soviet testing at their Shagan River test site indicate that the Soviets are observing a yield limit in their testing program. Our best estimates of this limit are consistent with TTBT compliance.

However, seismic signals vary due to inhomogeneities in the Earth and extrapolation of experience at the United States test site to the estimation of Soviet yields involves some uncertainty. As a result, the available data cannot preclude the possibility that some of the Soviet tests may have been greater than 150 kilotons.

This conclusion, which in part reflects the statistical uncertainty present in the estimation process, should be considered in perspective:

i) Seismic data observed from the United States' nuclear test program show variations similar to those seen in the seismic data from the Shagan River test site.

ii) Recent developments in the US understanding of the relationship between the seismic data forming the basis of our yield estimation procedures and the seismic data from the Shagan River test site indicate that the yields of these potential violations are significantly less than previous estimates.

Since I have no experience in the weapons' design areas of the Laboratory, I have little first hand knowledge of the military significance of testing at various yield levels. The information I do have indicates that a variety of opinions exist in this area. Combining those opinions which I consider most reliable with the estimates of monitoring capability which I have described above, I conclude that past potential violations are not militarily significant.

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2) Question: Is the TTBT verifiable?

Answer: In the sense described at the start of this letter and to the degree described in the answer to question 1, present monitoring methods allow verification of the TTBT.

The uncertainties in our monitoring capability are best understood for tests at the Shagan River test site. Other test sites have not been as well studied and our confidence in verification at these sites is correspondingly lower. Since the present Soviet testing practices do not include extensive programs at other sites, this increased uncertainty is not a problem at present.

3) Question: Is the PNET verifiable?

Answer: In the sense described at the start of this letter, the PNET is verifiable, but with somewhat greater risk than the TTBT.

The Soviets execute PNEs at sites scattered throughout their country. The properties of the seismic wave propagation beneath these sites can vary significantly, but the treaty does not provide a means to directly calibrate the seismic measurements for this effect. As a result, PNE explosions with nominal yields close to, but less than, 150 kilotons could have larger uncertainties than the yields for explosions at the test sites. (Group explosions with nominal yields greater than 150 kilotons allow the deployment of US equipment to obtain an independent estimate of the yield of each device.) Therefore, under the terms of the present PNET, there is the potential for an occasional militarily significant violation. However, PNE applications since 1976 have used yields whose estimates are significantly less than the 150 kiloton limit.

Other factors constrain the execution of a sustained program of significant violations:

i) The yield of the device must be consistent with the purpose of the experiment.

ii) The observed effects of the explosion must be consistent with the nominal yield. For example, higher yields have often been associated with cratering events, whose surface effects can be observed.

iii) The PNET would establish a Joint Consultative Commission to implement data exchange and to resolve questions regarding each country's actions with regard to the PNET. This provision would provide a forum for discussion of compliance issues.

4) Question: Would verification of these two treaties be enhanced by their ratification?

Answer: Verification of the two treaties would be enhanced by their ratification.

For the most part, the enhancement would be of a qualitative nature, affecting our confidence in our procedures rather than providing a specific quantitative improvement in yield estimation capability. For example, the proposed exchange of uncertified yields from calibration explosions will not reduce the quantitative uncertainty in our yield estimation capability. The exchange would establish a measure of consistency for past and future observations and would affect our confidence in relating experience at our test site to the explosions at their test site. Also, information about the geology and the material properties of the weapons test sites and the many PNE sites, together with information about the purpose of the PNEs, would serve to reduce the number of assumptions that are now made in order to evaluate compliance. Exchanges through the Joint Consultative Commission would clarify many issues.

A number of additional measures consistent with the present terms of the treaties might be invoked to increase our confidence in our monitoring capability. Among these are:

i) independent certification of calibration yields, using US means other than seismic.

ii) exchange of information about regional biases in seismic signal propagation, and

iii) retroactive exchange of the data on PNEs which would have been exchanged had the treaty been ratified immediately after signing.

Other, more intrusive measures have also been suggested.

These views are based upon my assessment of the information available to me and should not be construed as the views of the Laboratory or the Department of Energy.

If I can be of further service, please let me know.

Sincerely,

Willard J. Hannon
Program Manager
Seismic Monitoring Research Program

WJH/bb:6000N

APPENDIX 18

STATEMENT FROM THE RIPON SOCIETY IN SUPPORT OF H.J. RES. 3

THE RIPON SOCIETY

6 LIBRARY COURT, S.E.
WASHINGTON, D.C. 20003
(202) 546-1292

May 7, 1985

The Honorable Dante Fascell
Chairman
House Foreign Affairs Committee
2170 Rayburn House Office Building
Washington, DC 20515

Dear Chairman Fascell:

On April 15th, the members of the Ripon Society at their annual meeting voted unanimously to support House Joint Resolution 3, calling for ratification of the Peaceful Nuclear Explosions and Threshold Test Ban Treaties and vigorous pursuit of a verifiable Comprehensive Test Ban Treaty. As the President of the Society, I would like to take this opportunity to share our views with you and to encourage the House Foreign Affairs Committee to proceed with mark-up of H. J. Res. 3 and favorably report it to the full House of Representatives for consideration.

The Ripon Society is one of the leading moderate Republican voices in the country today. Our history spans the time frame of the movement toward a comprehensive ban on the testing of nuclear weapons which started with the 1963 Limited Test Ban and the 1968 Nuclear Non-Proliferation Treaties. We believe the goal of major reductions in the world's nuclear arsenals, as currently being negotiated at the START talks in Geneva, remains an important concept in stemming the threat of nuclear confrontation between the Superpowers. But as imposing and frightening as the figures are, reduction in absolute numbers will in reality be a slow and difficult process.

Thus, we believe the implementation of a Comprehensive Test Ban Treaty not only to be a logical and prudent complement to the Geneva discussions, but that it may be the single most valuable and attainable agreement that could be signed in the immediate future. A test ban treaty will ensure a limitation of the mad scramble for more accurate and elusive weapons delivery systems that is in many ways a more dangerous aspect of the nuclear arms situation.

Previous arguments against a CTB Treaty have often centered on the unreliability of verification methods. Such assertions may have had reasonable merit ten or twenty years ago, but evidence now strongly indicates that the technological capability needed to monitor for weapons-level testing has reached a point where such arguments are no longer valid.

Leading authorities in the field of seismology claim that any underground detonation of a nuclear device in the Soviet Union over a one KILOton strength (the bomb dropped on Hiroshima was 13 KILOtons) could be reliably detected, particularly if there is mutual adherence to provisions in the unratified TTB and PNE treaties. Ratification of these two existing treaties will provide unprecedented means of seismological data exchange and measures for on-site inspection of testing facilities--considered a major breakthrough in Soviet relations--and noninterference in monitoring. Taken together, these factors would provide vastly greater public confidence in limiting Soviet nuclear testing and further break down traditional Soviet barriers against on-site monitoring.

This aspect of verification has broader political implications as well. If successfully pursued, it will give a significant measure of assurance to the American people, Congress, and the rest of the world that a major factor in non-proliferation will, for the first time, be able to be reliably monitored. U.S. domestic support for subsequent arms reduction agreements, a problem in past treaties (e.g. SALT), would be greatly enhanced if the reliability of a CTB Treaty was not subject to potentially undetected and unverifiable violations by the Soviets. It would serve to relieve some of the pressure for a quick and possibly inadequate agreement in Geneva, due in part to the high level of anxiety in both the U.S. and Europe and the perhaps unrealistic expectations that have been built-up by the Reagan Administration, by furnishing tangible progress in the overall arms negotiation picture.

A further advantage of a CTB Treaty is the impact it will have on the cause of global nuclear non-proliferation, by the example it will set for the majority of the world's nations that are as yet without these weapons.

Implementation of a well-monitored, verifiable, and bilateral ban on weapons testing will be a significant step toward responsibly slowing, and ultimately stopping, the dangerous spiral of nuclear arms. Approval of the existing treaties and resumption of the stalled talks on a comprehensive testing ban will, we feel, go a long way toward both improving the atmosphere of the current talks and providing an immediate lessening of tensions.

We, therefore, ask for your strong commitment to House Joint Resolution 3, and to negotiations aimed at completion of a treaty to end all testing of nuclear weapons.

Sincerely yours,

Kenneth J. Grossberger
President, The Ripon Society

KG:jn

APPENDIX 19

STATEMENT FROM PHYSICIANS FOR SOCIAL RESPONSIBILITY IN SUPPORT OF A CTB

May 8, 1985

The National Security Case for House Joint Resolution 3

Over twenty years ago, when nuclear tests were still aboveground, the doctors and dentists of Physicians for Social Responsibility (PSR) helped make the case for a Comprehensive Test Ban (CTB). Fallout from the tests had made its way through the food chain and strontium 90 was found in children's teeth. Today, with the public reawakened to the dangers of the continued nuclear arms race, there is no strontium 90 in children's teeth but we find ourselves in a far more dangerous world confronted with practically the same arguments for and against a CTB.

If we could have negotiated a CTB in 1963 these halls would not now be filled with heated debate over MIRVs, small mobile missiles, ground-hugging cruise missles, backpack tactical warheads, strategic defense. We are haunted by our failure to live up to what is diplomatically possible. Over twenty years later, the case for a CTB is even more compelling. No longer can credible arguments be made that technical obstacles stand in the way; to end nuclear explosions -- verifiably, multilaterally -- all that is needed is the political will.

What a CTB would accomplish:
A CTB alone would not stop the nuclear arms race. Although testing is required for the development of new warheads, new delivery vehicles can use warheads already present in the stockpile. A CTB would consititute the simplest, most effective and verifiable first step that the superpowers could take towards halting the vertical and horizontal nuclear arms race.

a) The CTB would be a crucial non-proliferation measure -- The U.S. is committed to the achievement of a CTB in three separate international treaties (LTBT, NPT and TTBT). In fact, it is becoming increasingly clear that the eventual survival of the Non-Proliferation Treaty, which is due to be reviewed by 125 nations this September, depends upon superpower seriousness about a CTB. Furthermore, countries that have never signed the NPT such as Argentina or India have indicated their willingness to join the non-proliferation regime if the superpowers were truly committed to stopping their nuclear arms race.

On a global scale, a CTB could serve the same purpose today that it would have served 25 year ago had it been adopted by the superpowers; namely, preventing the transformation of basic nuclear fission-weapons capabilities into vast, highly differentiated nuclear weapons arsenals maintained and perpetually 'modernized' by highly secretive, economically wasteful nuclear weapons establishments. A multilateral CTB would make it much more difficult for a new-nuclear country to develop an arsenal that would be either easily deliverable or highly reliable.

b) Signing the treaty now would not place the U.S. at a disadvantage, in fact, the CTB would freeze the Soviets in a position of inferiority in warhead design. It is generally accepted that the efficiency of Soviet warheads (yield to weight ratios) is about half that of ours, placing them at about the level of the U.S. Poseidon developed in 1970. Given the substantial throwweight of their rockets, with further miniaturization of their warheads it is estimated that they could fit some 26 warheads in one SS18 missile for example (twice the throwweight of the MX). The new 10 warhead SSx24 has at present only moderate accuracy and kilotonnage ('hard-target lethality') but if the Soviets are allowed to develop small 500 kt warheads, the SSx24 would make any of our silos vulnerable.

c) A CTB would prevent the development of new and destabilizing warhead technologies. 'Third generation', directed energy weapons, such as Edward Teller's nuclear-powered X ray laser, are now being tested. There is an overwhelming case that such weapons would be most useful only in a first-strike scenario to destroy enemy satellites and disrupt communication. A CTB would prevent such a destabilizing development by both sides.

The arguments against a CTB:

Over the years, the arguments against a CTB have grown more sophisticated. Dramatic improvements in high-frequency seismic verification, in addition to substantial Soviet concessions on in-country tamper-proof seismic boxes and on-site inspections has led those committed to continued testing to expand their arguments against a CTB.

Stockpile reliability:
It is claimed that testing is necessary for the maintenance of adequate stockpile reliability. But, according to former Los Alamos Director Norris Bardbury and Los Alamos consultant, Richard Garwin, "It has been rare to the point of non-existence for a problem revealed by the sampling and inspection program to require a nuclear test for its resolution."

A level of nuclear weapons reliability sufficient for the task of threatening retaliation against an adversary's first-strike can be maintained indefinitely through a combination of thorough inspection, highly instrumented testing of the chemical explosive 'implosion' mechanism, conservatively designed fixes to proven designs already in the stockpile, and careful re-manufacturing methods. If we were truly serious about seeking an eventual test ban, it would direct the weapons labs to seek the means of coping with potential warhead deterioration. And even if over several decades there were some deterioration, the mutual degradation of nuclear stockpiles would merely enhance deterrence because it would inhibit planning by either side for an aggressive war.

Continued Modernization vs. Stopping:
The adminstration argues that the primary means for lessening the threat of nuclear war is reduction in the size of the nuclear arsenals, not a halt in the modernization process. It argues that continued modernization is vital for the maintenance of a stable deterrent and the success of negotiations. But the ultimate goal of arms control, in the words of ACDA Associate Director Richard Emery is to "reduce and eventually eliminate this dependence upon nuclear weapons."

Continued nuclear modernization by both superpowers can only make our problems graver. Faster, more accurate nuclear weapons increase the risk of nuclear war without leading to "reducing and eventually eliminating this dependence upon nuclear weapons." The Soviets invariably replicate our advances, shortening still further the warning time in a hair trigger world. Depressed trajectory technology, MIRVed mobile missiles, launch-on-warning, these are some of the advances that await us unless the superpowers takes mutual steps to halt 'modernization.'

The TTBT and PNET:

H J Res 3 calls not only for resumption of CTB negotiations but also for the ratification of two treaties, the Threshold Test Ban Treaty (TTBT) and the Peaceful Nuclear Explosions Treaty (PNET). Ratification of these treaties would create, for the first time, a cooperative monitoring regime that would substantially increase confidence in our ability to verify test ban treaties of the threshold type. Given that the U.S. has not ratified any of the treaties it has signed since the early 1970's, ratification of these treaties, negotiated and signed by Presidents Nixon and Ford respectively, would begin the process of restoring confidence through progress in arms control.

In a highly controversial move the administration has accused the Soviets of not complying with the unratified TTBT. But there is virtual agreement in that part of the seismological community which is not directly connected with the administration or the weapons labs with the substance of an article published in "Scientific American" (October, 1982). According to the article, "When the correct calibration is employed, it is apparent that none of the Russian weapons tests exceed 150kt, although several come close to it." The administation's accusation remains puzzling when it is considered that ratification of the treaties would provide for precisely the kind of exchange of seismic data that would make such compliance disagreements less likely.

Before it is willing to submit the TTBT and PNET for ratification, the administration has called for renegotiation of their verification procedures, suggesting that both countries send representatives to observe and calibrate the other's nuclear explosion tests. This is unfortunately the sort of intrusive verification proposal the Administration knows in advance that the Soviets will reject.

It is possible that beneath this concern for compliance and verification lies a desire to leave open the U.S. option of testing above 150kt. In fact in 1982, before the Senate Foreign Relations Committee former ACDA Director Eugene Rostow stated that he had "run into a profound stone wall" from the administration over the question of TTBT verification.

Conclusion:

When confronted with arguments against the CTB it would do us well to remember the kind of opposition even the LTBT received in 1963. Edward Teller testified against the LTBT, which has had indubitably profound health and environmental benefits for mankind, saying: "If you ratify this treaty you will have given away the future safety of this country."

The American people understand that that we are capable of stopping the nuclear arms race. Let us begin creating the political will today.

APPENDIX 20

STATEMENT FROM OLDER WOMEN'S LEAGUE IN SUPPORT OF H.J. RES. 3

Older Women's League™
NATIONAL OFFICE
1325 G Street, N.W., Lower Level B, Washington, DC 20005
(202) 783-6686

April 25, 1985

The Honorable Dante Fascell, Chairman
Committee on Foreign Affairs
U.S. House of Representatives
Washington, D.C. 20515

Dear Congressman Fascell:

I am writing on behalf of the Older Women's League (OWL), a national advocacy organization with over 13,000 members, to thank you for your efforts to bring about a Comprehensive Test Ban treaty and to express support for passage of House Joint Resolution 3.

While the Older Women's League has consciously focused its attention on issues of special concern to midlife and older women, an exception has been made on nuclear arms control--an issue at the heart of our very survival. Out of OWL's second biennial convention in 1984 came a mandate from our membership to take a stance on controlling the arms race and preventing nuclear war. A Comprehensive Test Ban treaty is an important step in the direction of preventing nuclear war; it is a step toward a comprehensive halt in producing, testing and deploying new nuclear weapons.

We are pleased to know that H.J. RES 3 is the subject of upcoming hearings and hope your Subcommittee will approve this resolution and bring it to a favorable vote before the full House of Representatives. Again, thank you for your continued work on this vital issue.

Sincerely,
Victoria Jaycox
Victoria Jaycox
Executive Director

APPENDIX 21

STATEMENT FROM FRIENDS OF THE EARTH IN SUPPORT OF H.J. RES. 3

FRIENDS OF THE EARTH
530 7TH STREET, S.E., WASHINGTON, D.C. 20003
(202) 543-4312

April 17, 1985

The Honorable Dante Fascell, Chairman
Committee on Foreign Affairs
U.S. House of Representatives
Washington, DC 20515

Dear Mr. Chairman:

In the ongoing effort to stop the nuclear arms race, there is no more certain step we can take than to finally halt all testing of nuclear warheads. A Comprehensive Test Ban will be the first step in a nuclear weapons freeze, halting the development of a new generation of nuclear weapons, preventing the unraveling of the Non-proliferation Treaty, protecting the environment and lightening the burden of excessive military spending. A CTB is verifiable by national technical means and achievable right now by mutual moratorium pending negotiation of a final treaty.

The reluctance of President Reagan to pursue Senate ratification of the already negotiated Threshold Test Ban and Peaceful Nuclear Explosions Treaties, and his refusal to resume negotiations for a Comprehensive Test Ban, put the onus squarely on Congress to advance this vital arms control initiative. The Bedell-Leach resolution provides the House with a vehicle to register its support for a ban on testing and to push the Reagan Administration to pursue negotiations toward that end. We urge the Committee on Foreign Affairs to report out H.J. RES. 3 and request that you work earnestly for its passage by the full House of Representatives at the earliest opportunity.

It is time for the House to encourage a prompt end to nuclear testing. Friends of the Earth stands ready to work with you for passage of H.J. RES. 3 as an integral part of our commitment to preventing the proliferation of nuclear weapons and reducing the greatest environmental threat facing the planet.

Sincerely,

David Lewis

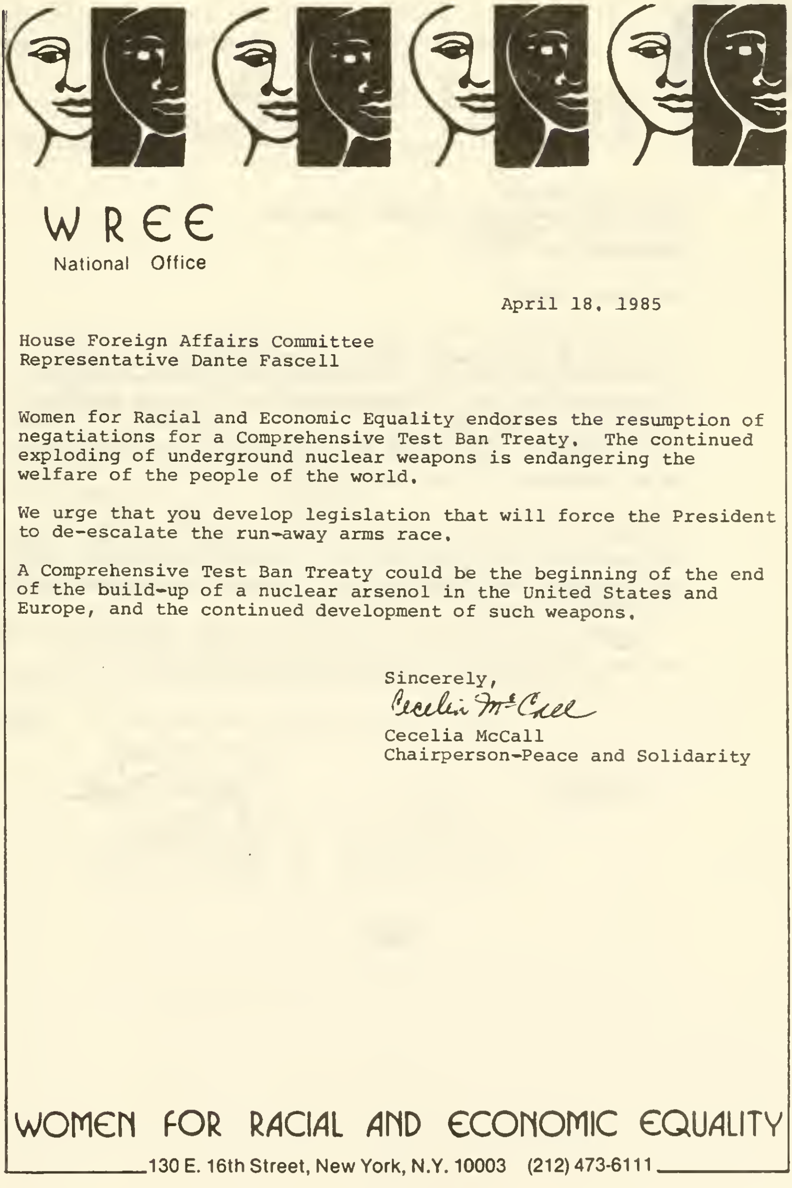
David Lewis
Arms Control Specialist

Committed to the preservation, restoration, and rational use of the ecosphere

100% recycled paper

APPENDIX 22

STATEMENT FROM WOMEN FOR RACIAL AND ECONOMIC EQUALITY IN SUPPORT OF A CTB



WREE
National Office

April 18, 1985

House Foreign Affairs Committee
Representative Dante Fascell

Women for Racial and Economic Equality endorses the resumption of negatiations for a Comprehensive Test Ban Treaty. The continued exploding of underground nuclear weapons is endangering the welfare of the people of the world.

We urge that you develop legislation that will force the President to de-escalate the run-away arms race.

A Comprehensive Test Ban Treaty could be the beginning of the end of the build-up of a nuclear arsenol in the United States and Europe, and the continued development of such weapons.

Sincerely,
Cecelia McCall
Cecelia McCall
Chairperson-Peace and Solidarity

WOMEN FOR RACIAL AND ECONOMIC EQUALITY
130 E. 16th Street, New York, N.Y. 10003 (212) 473-6111

APPENDIX 23

STATEMENT FROM PLANETARY CITIZENS IN SUPPORT OF A CTB

P.O. BOX 426 MENLO PARK CA 94026 USA 415 325 2939

April 15, 1985

Hon. Dante Fascell
Chairman, House Foreign Affairs Committee
2170 Rayburn Building
Washington, DC 20515

Dear Hon. Fascell,

A Comprehensive Test Ban is a vital component in diminishing the threat of nuclear war. Such a ban would have a major impact in establishing the context for successfully slowing and reversing the arms race momentum. A completed test ban would have the effect of reducing the spiraling research on both sides into more destructive weapons systems, thus enabling the nuclear nations to focus more on the improvement of relations for successful negotiations, rather than on the competition for advanced weaponry.

A CTB is in our national interest. Not only will it save billions of dollars in research and allow us to turn towards constructive venues for development, it will also aid in focusing the nuclear power nations on the need for the establishment of a system for international security in which all parties can feel secure.

We urge you to support the completion of the Comprehensive Test Ban as a step toward a safe and secure future.

Sincerely yours,

Francis Weller
Executive Director

APPENDIX 24

STATEMENT FROM SOLAR LOBBY IN SUPPORT OF A CTB

Solar Lobby
1001 connecticut avenue, nw suite 638 washington, dc 20036 (202) 466-6350

THE SOLAR LOBBY SUPPORTS THE INCREASING USE OF CONSERVATION AND RENEWABLE ENERGY AS ALTERNATIVES TO THE PROLIFERATION OF FISSIONABLE MATERIALS AND TECHNOLOGY THAT COULD BE USED IN THE DEVELOPMENT OF NUCLEAR WEAPONS.

THIS POSITION IS IN ACCORD WITH NATIONAL AND CONGRESSIONAL EFFORTS TO EXPLORE AVENUES LEADING TO AN INTERNATIONAL FREEZE ON NUCLEAR WEAPONS TESTING AND ON NUCLEAR DISARMAMENT IN GENERAL. THE SOLAR LOBBY ENDORSES THESE EFFORTS.

Tina C. Hobson

Tina C. Hobson
Executive Director
8 April 1985

APPENDIX 25

STATEMENT FROM NATIONAL COUNCIL FOR THE SOCIAL STUDIES IN SUPPORT OF A CTB

PRESIDENT

Please reply to:

Donald H. Bragaw
Bureau of Social Studies Education
New York State Education Department
Washington Avenue, Rm. 312 EB
Albany, New York 12234
(518) 474-5978

April 16, 1985

The Honorable Dante Fascell
Chair
House Foreign Affairs Committee
2170 Rayburn Building
Washington, D.C. 20515

Dear Congressman Fascell:

At their November, 1982 annual meeting, the National Council for the Social Studies in the assembled House of Delegates strongly supported measures to bring about a halt in nuclear weapon build-up. That sentiment has not been altered.

Efforts to bring about a Comprehensive Test Ban (CTB) Treaty would be in line with the Delegate's position. I would urge you and the House Foreign Affairs Committee to give every consideration to urging such a Treaty.

Sincerely,

Donald H. Bragaw

Donald H. Bragaw, President

cc: Fran Haley
Paul Shires
Jan Tucker

APPENDIX 26

STATEMENT FROM UNITED ELECTRICAL, RADIO AND MACHINE WORKERS OF AMERICA IN SUPPORT OF H.J. RES. 3

United Electrical, Radio and Machine Workers of America
ELEVEN EAST FIFTY-FIRST STREET UE NEW YORK, N.Y. 10022 • 753-1960

JAMES M. KANE
General President

BORIS H. BLOCK
General Secretary-Treasurer

HUGH HARLEY
Director of Organization

STATEMENT OF SUPPORT

for

H. J. RES. 3

As you prepare to markup the H. J. Res. 3, the United Electrical, Radio and Machine Workers of America (UE) join with other members of Citizens Against Nuclear War in expressing support for a freeze on the testing, production and deployment of nuclear weapons.

I quote from our union's 49th Convention Resolution in 1984 on military spending, peace and jobs:

> "Resolve # 3 - Supports ratification of the Salt II agreement and a mutual, verifiable freeze on further production, deployment and testing of nuclear weapons as steps towards deep reductions in military spending, armaments and the elimination of nuclear weapons from the face of the earth.
>
> "Resolve # 8 - Supports the transfer of a substantial amount of military spending into programs that meet the needs of the people and creates jobs and calls on UE locals and districts to work with other groups in pursuing these goals."

Thank you for your consideration.

James M. Kane
General President

APPENDIX 27

Statement From the YWCA of the USA in Support of a CTB

National Board
YWCA of the U.S.A.
726 Broadway
New York, NY 10003
212-614-2700
Cable: Emissarius, NY

April 2, 1985

Hon. Dante Fascell
Chairman, House Foreign Affairs Committee
2170 Rayburn Building
Washington, DC 20515

Dear Congressman Fascell:

The YWCA of the U.S.A., at its 30th National Triennial Convention (San Jose, California: March 21-25, 1985) has adopted Peace with Justice as its international public policy priority, reaffirming its commitment:

> "to work for a United States foreign policy which places highest priority on peace and mutual disarmament, supports a United Nations empowered to maintain international peace, and replaces excessive military spending with policies that enhance the economic and social well being of people."

In light of recent Convention action and the YWCA of the U.S.A.'s longstanding support of the Peace Priority, we are indeed pleased to note the high priority you have placed on arms control, nuclear testing and the anti-satellite weapons program (ASATs) in your capacity as Chairman of the House Foreign Affairs Committee. We also note with encouragement your decision to hold hearings on the Comprehensive Test Ban Treaty in committee and to bring House Joint Resolution 3 (introduced by Representatives Berkley (D-Iowa), Jim Leach (R-Iowa) and Ed Markey (D-Mass.) to the House floor for a vote,

With best wishes,

Yours sincerely,

Gwendolyn Calvert Baker

Gwendolyn Calvert Baker
Executive Director

GCB: RRB/rs

YWCA
Affiliated with the World YWCA
...in the struggle for peace and justice, freedom and dignity for all people

APPENDIX 28

STATEMENT FROM NATIONAL ASSOCIATION OF SOCIAL WORKERS, INC. IN SUPPORT OF A CTB

April 10, 1985

Honorable Dante Fascell
Chairman, House Foreign Affairs Committee
2170 Rayburn House Office Building
Washington, D. C. 20515

Dear Representative Fascell:

The 100,000 member National Association of Social Workers commends you for your leadership in seeking effective arms control as an important component of our country's national security. Our profession has always been deeply committed to the resolution of conflict by peaceful means. We support the bipartisan efforts within Congress to urge the President to resume negotiations for a Comprehensive Test Ban treaty. A halt in nuclear weapons testing would reduce the risk of nuclear war, inhibit the proliferation of nuclear weapons, eliminate health and environmental hazards, and cut military spending.

Beyond the threat of the nuclear arms race is the continual drain of energies and resources to military hardware while programs which invest in human resources are slashed. Our nation's priorities must be reordered - away from excessive military expenditures toward programs which protect and nurture human life.

We are counting on your vote in support of HJ Res. 3.

Sincerely yours,

Mark Battle

Mark G. Battle, ACSW
Executive Director

APPENDIX 29

Statement From American Public Health Association in Support of H.J. Res. 3

AMERICAN PUBLIC HEALTH ASSOCIATION
1015 Fifteenth Street, N.W., Washington, D.C. 20005 • (202) 789-5600

H.J. Res. 3 Comprehensive Test Ban Treaty
Statement of
American Public Health Association
1015 Fifteenth Street, NW
Washington, DC 20005
(202) 789-5650

The American Public Health Association representing a combined national and affiliate membership of nearly 50,000 public health professionals and community health leaders, supports H.J. Res. 3 providing for a comprehensive test ban treaty on nuclear explosions. APHA views the comprehensive test ban treaty as the first step toward a comprehensive freeze on the testing , production and deployment of new nuclear weapons.

APHA recognizes that there is strong interrelationship between military buildup and spending increases and grossly inadequate health and human service spending, and is concerned about the order of priority this relationship represents for the nation.

APHA believes that billions of dollars spent on new weapons can be put to better use in this nation, and throughout the world, in public health programs which prevent debilitating diseases and provide people with an opportuntiy to fulfill their human potential.

We urge you to vote in favor of H.J. Res. 3.

APPENDIX 30

Statement From American Federation of State, County and Municipal Employees in Support of H.J. Res. 3

American Federation of State, County and Municipal Employees
1625 L Street, N.W., Washington, D.C. 20036
Telephone (202) 429-1000
Telex 89-2376

April 26, 1985

The Honorable Dante Fascell
Chairman
House Foreign Affairs Committee
2170 Rayburn House Office Building
Washington, D. C. 20515

Dear Mr. Chairman:

The American Federation of State, County and Municipal Employees (AFSCME), a labor union representing public employees nationwide, takes this opportunity to endorse H.J.Res. 3, which calls for President Reagan to resume negotiations on a Comprehensive Test Ban Treaty (CTB).

Though the Limited Test Ban Treaty of 1963 prohibits nuclear explosions in the atmosphere, outer space, and underwater and the unratified Threshold Test Ban Treaty (TTBT) and the Peaceful Nuclear Explosions Treaty (PNET) forbid underground explosions over 150 Kilotons, a Comprehensive Nuclear Test Ban is necessary for (1) total prohibition on all nuclear explosions for military or peaceful purposes and in all atmospheres and, (2) prohibition of explosions for peaceful purposes to prevent their clandestine military use and to protect the environment. In addition, H.J.Res. 3 calls on the President to request consent to ratification of the TTBT and the PNET.

A Comprehensive Test Ban has been an objective of every President since the Eisenhower Administration and represents a substantial step toward halting the qualitative offensive nuclear arms race, controlling further proliferation of nuclear capabilities to other countries, eliminating health and environmental hazards, and cutting military spending. Ratification of the Comprehensive Nuclear Test Ban is particularly important now because it may take the parties in Geneva years to reach agreement while the nuclear arms race continues to accelerate on both sides.

During AFSCME's 26th International Convention, our members ratified a resolution calling for the negotiation of a mutual freeze on all production, deployment and testing -- including underground testing -- of nuclear weapons systems. We hope that the Congress will register its opposition to nuclear proliferation by supporting H.J. Res. 3.

Sincerely,

William B. Welsh
Director of Legislation

WBW:mlm

APPENDIX 31

STATEMENT FROM THE OFFICE FOR CHURCH IN SOCIETY OF THE UNITED CHURCH OF CHRIST IN SUPPORT OF A CTB

UNITED CHURCH OF CHRIST
OFFICE FOR CHURCH IN SOCIETY
110 MARYLAND AVENUE N E • WASHINGTON, D C 20002 (202) 543-1517

April 1985

STATEMENT OF THE OFFICE FOR CHURCH IN SOCIETY OF THE UNITED CHURCH OF CHRIST
IN SUPPORT OF A COMPREHENSIVE TEST BAN TREATY

In 1963, the General Synod of the United Church of Christ called for "renewed effort by our government to reach agreement by the principal nuclear powers on the permanent cessation of nuclear weapons testing," and later reaffirmed this action in 1977 by calling on the U.S. to "continue actively toward a comprehensive test ban treaty."

Now in 1985 it is critical that the effort to ban all nuclear testing be pursued with such "renewed effort." For nearly forty years, the escalation of nuclear terror has been perpetrated upon the people of the world. The United States and the Soviet Union, to this point, have spearheaded this massive arms build-up while shrinking from the responsibility of making the world more secure.

Nations find new methods of waging war while failing to investigate the "things that make for peace." Meanwhile, rationalization runs rampant in foreign policy as missiles are named "peacekeepers," invasions are deemed the "protection of one's borders, and space weapons are developed for "defensive" purposes. With this rise in rationalization has come a slippage in rationality.

A Comprehensive Test Ban Treaty would restore some rationality to international relations by effectively limiting the escalation of the nuclear arms race.

The Office for Church in Society of the United Church of Christ believes a Comprehensive Test Ban would represent a historic movement toward a more peaceful world. Therefore, we call for immediate resumption of negotiations pursuing this treaty and urge the President to propose to the Soviet Union resumption of such talks.

APPENDIX 32

STATEMENT FROM THE AMERICAN MEDICAL STUDENT ASSOCIATION/ FOUNDATION IN SUPPORT OF H.J. RES. 3

April 16, 1985

Honorable Dante Fascell
Chairman, House Foreign Affairs Committee
2170 Rayburn Building
Washington, D.C. 20515

Dear Representative Fascell:

The American Medical Student Association supports House Joint Resolution 3, a positive step towards a Comprehensive Test Ban Treaty (CTBT). A CTB represents a politically and scientifically workable means of curbing the arms race.

When the US, USSR, and Great Britain initiated and ratified the Limited Test Ban Treaty in 1963, they prohibited nuclear tests in the atmosphere, outerspace and underwater, but not underground. These countries were committed to a comprehensive test ban in idea, but felt that underground testing could not be monitored with the technology of that time (in contrast to the other areas). Present scientists, such as physicist and former Atomic Energy Commission Chairman Glenn Seaborg, are confident of our ability to detect underground explosions of even 1 kiloton bombs. With such technology, the verifiability issue should not be decisive.

The Reagan administration has opposed a CTBT because nuclear testing is essential to the development of new weapons systems. But, a limit on nuclear testing would provide a verifiable means of slowing the arms race on both sides of the Atlantic. A CTBT would direct the political climate toward an arms control agreement, and would make more effective the Nuclear Non-Proliferation Treaty of 1970.

The American Medical Student Association is a national organization of over 30,000 allopathic and osteopathic medical students throughout the United States. It is an independent organization of physicians-in-training committed to the promotion of health and the prevention of disease. AMSA recognizes nuclear war as the greatest global threat to public health. Because there can be no effective medical response in the aftermath of such a war, such a catastrophe must be prevented by appropriate political measures. Accordingly, AMSA urges the United States Government to pursue negotiations toward a Comprehensive Test Ban Treaty.

Sincerely,

Helen Burstin
National President

Elaine Schattner

Elaine Schattner
National Coordinator
AMSA Task Force on the
Prevention of Nuclear War

APPENDIX 33

Statement From National Education Association in Support of a CTB

May 7, 1985

The Honorable Dante Fascell, Chairman
House Foreign Affairs Committee
2170 Rayburn House Office Building
Washington, D.C. 20515

Dear Chairman Fascell:

The National Education Association has, for some time, advocated for ending the Administration's increasing emphasis on perfecting and developing nuclear weapons. We have supported a freeze on "Testing, development, production, upgrading, emplacement, and deployment of nuclear weapons and all systems designed to deliver nuclear weapons" (NEA Resolution H-32-Nuclear Freeze).

Our nation must concentrate its efforts on improving the quality of life for our own citizens and searching for the means to offer our traditional democratic values to others beyond our borders. We object to devoting so much human creativity to development of sophisticated weaponry while failing to devote even meager attention to finding ways to build national confidence that we have the ability to reach satisfactory accommodation with other nuclear powers to end the accumulation of nuclear weapons.

We support the efforts of those in Congress who wish to work out the components of a Comprehensive Test Ban Treaty. We recognize and agree that all such components must be verifiable. But we believe it is possible to establish verification instrumentation, procedures, and techiques to assure compliance by treaty partners, and we urge the Congress to adopt that view.

We are hopeful about the outcome of the negotiations now taking place in Geneva. In that context, we urge the Congress to pursue serious arms control through the Comprehensive Test Ban Treaty.

We applaud your efforts toward international understanding and world peace.

Very sincerely,

Mary H. Futrell

Mary Hatwood Futrell
President

MHF/dw

APPENDIX 34

Statement From the Presbyterian Health, Education and Welfare Association in Support of a CTB

Hon. Dante Fascell
Chairman, House Foreign Affairs Committee
2170 Rayburn Building
Washington, D.C. 20515

Dear Rep. Fascell:

As the Executive Director of the Presbyterian Health, Education and Welfare Association, I would like to express support, on behalf of our organization, our constituency and our staff, for the establishment of a verifiable Comprehensive Test Ban Treaty.

The Presbyterian Health, Education and Welfare Association (PHEWA) is a voluntary membership organization of lay and clergy persons involved in the social ministries related to the Presbyterian Church (U.S.A.). As such, we touch a constituency of some 3,500,000 Presbyterians.

Since our constituency is primarily involved with issues of social justice in our country and in our world, peacemaking concerns are a naturally adjunct concern of our organization. We are very concerned about the latest developments that seem to escalate further an already insane arms race.

In thinking seriously about the advantages and disadvantages of a CTB, we believe that the positive results will far outweigh the risks.

In these days of advanced technology, when "the verifiability question" often throws a monkey wrench into even the most well argued and designed arms control treaties, a distinct advantage of a CTB treaty is that it can be verifiable. It's quite difficult to hide a nuclear explosion. In response to those who fear that the Soviets would "cheat," intellegence experts and scientists have testified that underground nuclear explosions as small as one kiloton now can be detected.

We believe that a verifiable Comprehensive Test Ban Treaty is a first step toward de-escalating a dangerous arms race, and that it is a sign of good stewardship of our country and our world. The CTB will give incentive to halt a technological race for more dangerous, faster, less detectable nuclear weapons and would be the first step toward a comprehensive nuclear freeze. The CTB would save billions of dollars each year. The CTB would strengthen non-nuclear powers' belief in the value of non-proliferation (in keeping with the spirit of the Non-Proliferation Treaty). The CTB would represent yet another step toward improving the climate of US/Soviet arms negotiations. The CTB would help to ensure human safety and animal health in the U.S. and other parts of the world.

I hope that you will take seriously these comments and our position on this issue. The will of the American public is clear, in its overwhelming support of a nuclear freeze.

Thank you for hearing us.

Sincerely,

Rodney T Martin

Mr. Rodney T. Martin, Executive Director
Presbyterian Health, Education and Welfare Association (PHEWA)

RTM/jv

cc: Sara Flagg
L. Robert Frere
James Noel

APPENDIX 35

Statement From Citizens Against Nuclear War in Support of H.J. Res. 3

May 7, 1985

The Honorable Dante Fascell
Chairman
House Foreign Affairs Committee
2170 Rayburn House Office Building
Washington, D.C. 20515

Dear Mr. Chairman,

Thank you for scheduling action on legislation calling for resumption of negotiations for a Comprehensive Test Ban Treaty. Citizens Against Nuclear War, a coalition of 58 national organizations, endorses H. J. Res. 3, which is before your Committee.

Our statement of support for H. J. Res. 3 is attached, with additional supporting statements from many of our member organizations. Please add these statements to your Committee's hearing record.

Sincerely,

Karen Mulhauser

Karen Mulhauser
Executive Director

cc: Members of the House Foreign Affairs Committee
KM/tt

STATEMENT

PRESENTED TO THE HOUSE FOREIGN AFFAIRS COMMITTEE

BY KAREN MULHAUSER, EXECUTIVE DIRECTOR,
CITIZENS AGAINST NUCLEAR WAR

IN SUPPORT OF H.J.Res. 3

Citizens Against Nuclear War is part of one of the largest grass-roots movements in our nation's history. What unites the movement is a demand by citizens from every sector of society for an end, now, to the nuclear arms race. The goal of the Freeze Movement is a negotiated, verifiable agreement between the United States and Soviet Union to halt the testing, production and deployment of all nuclear weapons, followed by deep reductions in both nations' nuclear stockpiles.

We regard a Comprehensive Test Ban as a substantial first step toward that goal. It was nearly achieved five years ago, when the negotiators for our country, Great Britain and the Soviet Union reported their agreement on the main outlines of a treaty to ban all nuclear testing. Since then, scientific discoveries have made verification of compliance with the no-testing rule far surer than before.

Unfortunately, over the same time period the nuclear competition between the superpowers has speeded up while the negotiating process stalled. Both our nation and the Soviet Union are poised to develop a new generation of weapons so accurate, so deadly, and so difficult to detect that once they are tested and produced, the world may have lost its last opportunity for controlling the nuclear arms race.

International agreement on a Comprehensive Test Ban will control that arms race, prevent development of that feared new generation of weapons, and lend strength to the Non-Proliferation Treaty.

Recent developments demonstrate that fear of the nuclear arms race is growing throughout the world. Thanks to the initiative of the World Parliamentarians organization, government leaders in six non-nuclear nations have formed a Five Continent Peace Initiative stressing the global impact of a nuclear war. The six leaders, the presidents or prime ministers of Argentina, Greece, India, Mexico, Sweden and Tanzania, are taking their anti-nuclear message directly to the leaders of the five nuclear powers. They are strongly urging resumption of negotiations for a Comprehensive Test Ban Treaty.

In April government leaders from 24 countries, meeting as the Council of Former Heads of Government, called on the nuclear states to suspend all weapons testing while the U.S./Soviet arms control talks proceed. Signers of the appeal included former West German Chancellor Helmut Schmidt, former British Prime Minister James Callaghan, and former prime ministers of Japan, Canada, Zambia, Hungary and Yugoslavia, among others.

It is gratifying to Citizens Against Nuclear War that the U.S. Congress is considering appealing to President Reagan to resume negotiations for a Comprehensive Test Ban Treaty and to submit the signed treaties for a Threshold Test Ban and Peaceful Nuclear Explosions to the Senate for ratification. Last year the Senate passed an amendment identical to the text of H.J.Res. 3 by the impressive vote of 77 to 22. In this new Congress almost 150 Representatives have agreed to cosponsor that joint resolution. We urge the Committee on Foreign Affairs to put its stamp of approval on H.J.Res. 3 and ask for a favorable vote by the House of Representatives.

Endorsement of resumed negotiations for a Comprehensive Test Ban is likely to send an encouraging message to the nations that will assemble this fall to review the Non-Proliferation Treaty. The non-nuclear states are making it clear that they are losing patience with the nuclear arms race and the superpowers' failure to call a halt to underground nuclear tests. Non-proliferation efforts need strengthening, yet they are being dampened by the callous attitudes of the United States and Soviet governments.

Citizens Against Nuclear War is a coalition of 58 national membership organizations. Each of these organizations was formed for a purpose other than arms control, but their fear of the nuclear arms race is so great that they have joined together to work for a nuclear weapons freeze and other arms control objectives. Our member organizations represent mainstream America. They include professionals, union members, and different races and religions -- for example, The American Public Health Association and the YWCA, the Medical Student Association and the Federation of State, County and Municipal Employees, the Presbyterian Church and the Solar Lobby. One of the organizers of the drive for a Comprehensive Test Ban, Greenpeace USA, is a member of our coalition, and so are mainstream Republicans represented by the Ripon Society.

It is a pleasure to submit statements endorsing H.J.Res. 3 from many of our member organizations. Perusing them will show how wide and diverse the movement to end nuclear testing is in the United States.

Underlying these messages is the fear that time is running out. Before it's too late, before the next nuclear bomb explodes, the force of public opinion must be felt across our land and in the councils of the nuclear powers. When world opinion demands an end to nuclear explosions, governments, even totalitarian governments, will listen and act.

Citizens
against
Nuclear War
1201 Sixteenth Street, NW • Washington, DC 20036 • (202) 822-7483

Citizens Against Nuclear War
Member Organizations

May 1985

- ACORN - Association of Community Organizations for Reform Now
- Amalgamated Clothing and Textile Workers Union
- American Art Therapy Association
- American Association of University Women
- American Coalition of Citizens with Disabilities, Inc.
- American Federation of State, County and Municipal Employees
- American Jewish Congress
- American Library Association
- American Medical Student Association
- American Public Health Association
- Americans for Democratic Action
- Americans for Indian Opportunity
- Coalition of Black Trade Unionists
- Congress of Italian-American Organizations, Inc.
- Delta Sigma Theta Sorority
- Environmental Action
- Friends Committee on National Legislation
- Friends of the Earth
- Graphic Communications International Union
- Gray Panthers
- Greenpeace USA
- International Association of Machinists and Aerospace Workers
- International Brotherhood of Boilermakers
- International Chemical Workers Union
- International Woodworkers of America
- Japanese-American Citizens League
- League of United Latin American Citizens (LULAC)
- National Association of Social Workers
- National Black Caucus of State Legislators
- Coalition National Black Communications
- National Conference of Black Lawyers
- National Council for the Social Studies
- National Council of Negro Women
- National Council of Senior Citizens
- National Education Association
- National Union of Hospital and Health Care Employees
- National Women's Health Network
- The Newspaper Guild
- Nuclear Information & Resource Service
- Older Women's League
- Organization of Pan Asian American Women
- Planetary Citizens
- Presbyterian Church USA
- Presbyterian Health, Education and Welfare Association
- Reformed Church in America
- The Ripon Society
- Rural American Women
- Solar Lobby
- Southern Christian Leadership Conference
- Union of American Hebrew Congregations
- Unitarian Universalist Association
- United Church of Christ
- United Electrical, Radio and Machine Workers of America
- United Farm Workers of America
- United Food and Commercial Workers International Union
- United States Student Association
- The Wilderness Society
- Women for Racial and Economic Equality
- Young Women's Christian Association

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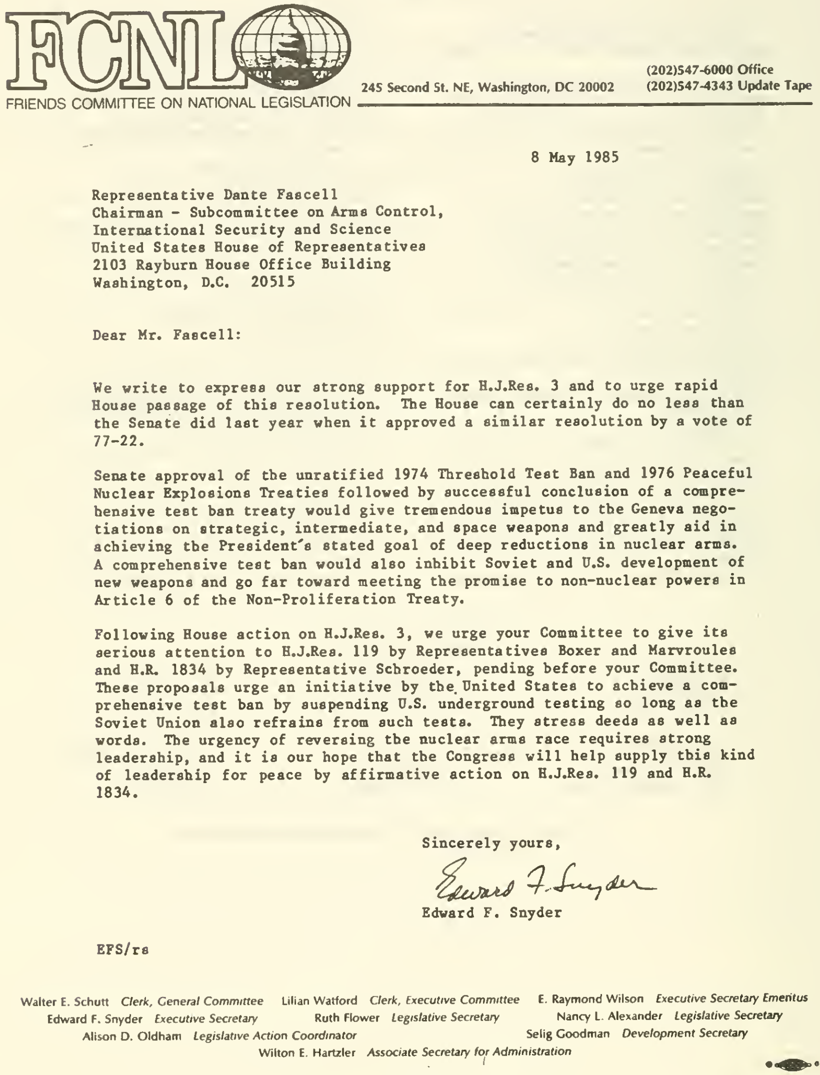
A Coalition of National Membership Organizations

APPENDIX 36

STATEMENT FROM FRIENDS COMMITTEE ON NATIONAL LEGISLATION IN SUPPORT OF H.J. RES. 3



FCNL
FRIENDS COMMITTEE ON NATIONAL LEGISLATION
245 Second St. NE, Washington, DC 20002
(202)547-6000 Office
(202)547-4343 Update Tape

8 May 1985

Representative Dante Fascell
Chairman - Subcommittee on Arms Control,
International Security and Science
United States House of Representatives
2103 Rayburn House Office Building
Washington, D.C. 20515

Dear Mr. Fascell:

We write to express our strong support for H.J.Res. 3 and to urge rapid House passage of this resolution. The House can certainly do no less than the Senate did last year when it approved a similar resolution by a vote of 77-22.

Senate approval of the unratified 1974 Threshold Test Ban and 1976 Peaceful Nuclear Explosions Treaties followed by successful conclusion of a comprehensive test ban treaty would give tremendous impetus to the Geneva negotiations on strategic, intermediate, and space weapons and greatly aid in achieving the President's stated goal of deep reductions in nuclear arms. A comprehensive test ban would also inhibit Soviet and U.S. development of new weapons and go far toward meeting the promise to non-nuclear powers in Article 6 of the Non-Proliferation Treaty.

Following House action on H.J.Res. 3, we urge your Committee to give its serious attention to H.J.Res. 119 by Representatives Boxer and Marvroules and H.R. 1834 by Representative Schroeder, pending before your Committee. These proposals urge an initiative by the United States to achieve a comprehensive test ban by suspending U.S. underground testing so long as the Soviet Union also refrains from such tests. They stress deeds as well as words. The urgency of reversing the nuclear arms race requires strong leadership, and it is our hope that the Congress will help supply this kind of leadership for peace by affirmative action on H.J.Res. 119 and H.R. 1834.

Sincerely yours,

Edward F. Snyder
Edward F. Snyder

EFS/rs

Walter E. Schutt *Clerk, General Committee* Lilian Watford *Clerk, Executive Committee* E. Raymond Wilson *Executive Secretary Emeritus*
Edward F. Snyder *Executive Secretary* Ruth Flower *Legislative Secretary* Nancy L. Alexander *Legislative Secretary*
Alison D. Oldham *Legislative Action Coordinator* Selig Goodman *Development Secretary*
Wilton E. Hartzler *Associate Secretary for Administration*

APPENDIX 37

STATEMENT FROM THE COMMITTEE FOR NATIONAL SECURITY IN SUPPORT OF H.J. RES. 3

CNS

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Chairman of the Committee
James F. Leonard
Chairman of the Board
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Stanley Resor
Robert D. Schmidt
Adele Simmons
Louise Mead Walker
Stanley Weiss
Adam Yarmolinsky
Anne H. Cahn, *Director*

May 14, 1985

The Honorable Dante Fascell
Chairman
House Foreign Affairs Committee
2170 Rayburn House Office Building
Washington, D.C. 20515

Dear Chairman Fascell:

On behalf of the Comprehensive Test Ban Task Force I want to express our strong support for H.J.Res. 3 which is before your Committee for consideration, and to thank you for the opportunity of registering our endorsement for the record.

The Task Force, under the co-chairmanship of Dr. Herbert Scoville and Dr. Betty Goetz Lall, devotes its efforts toward educating the public on the merits of a comprehensive test ban. The Committee for National Security is a nonprofit, nonpartisan leadership organization which seeks, through its activites and educational programs, to promote a broader understanding of national security issues.

An effective comprehensive test ban must be incorporated into a verifiable treaty open to the signature of all nations. Except for technical details, the Soviet Union, the United Kingdom, and the United States have already negotiatied such an agreement. Ninety percent of the treaty had been agreed upon when negotiations were suspended in 1980. Recent advances in the technological capability needed to monitor a ban gives assurances that such a treaty would indeed be verifiable.

Approval of H.J. Res. 3 by the Committee and by the full House would provide a powerful stimulus to resumption and successful conclusion of negotiations. This would start in motion a train of events on arms control negotiations and on nuclear non-proliferation that could pull the world back from the precipice toward which it is heading.

The prevention of nuclear war has become the categorical imperative of national security. The draft CTB treaty of 1980 is the most ready and effective means of getting this process underway.

Cordially,

Anne H Cahn

Anne H. Cahn

The Committee for National Security
2000 P Street, NW • Suite 515 • Washington, DC 20036 • 202-833-3140

APPENDIX 38

STATEMENT FROM JAMES T. BUSH, CAPTAIN USN (RETIRED) IN SUPPORT OF H.J. RES. 3

Testimony in Support of H. J. Res. 3
By James T. Bush
Captain USN (Ret.)

The Center for Defense Information has long favored a ban on all nuclear explosions as an essential step in slowing, stopping, and reversing the nuclear arms race. We strongly endorse H.J. Res. 3 as a step in the right direction because it calls on the President to take significant actions that will enhance the liklihood of concluding an agreement that will end all nuclear explosions.

Almost 1,500 nuclear weapons have been exploded since the Nuclear Age opened forty years ago with the first atomic test on 16 July 1945. The purpose of the majority of these nuclear explosions has been to test new nuclear weapons designs, gauge the effects of nuclear detonations on military equipment, or to verify the reliability of nuclear weapons already in the stockpiles of the nuclear-armed nations. Two of these nuclear explosions, however, destroyed two Japanese cities: Hiroshima on 6 August 1945 and, three days later, Nagasaki. Almost 200,000 people died in the immediate aftermath and human beings are still suffering and dying today from the effects of those two nuclear explosions.

Despite the many wars that have wracked the world since the Japanese surrender, nuclear weapons have not been exploded in anger since the Nagasaki bombing. This is a remarkable fact--and one for which we should all be thankful. But over that same period of time the U.S. and the U.S.S.R. have accumulated between them some 50,000 of these devastating weapons. The continued explosive testing of nuclear weapons increases the likelihood that the tragedies of Hiroshima and Nagasaki will be repeated, a thousand-fold, the world over.

There are four compelling reasons to put an end to all nuclear explosions:

o Because of the over 700 nuclear tests the U.S. has conducted during the last 40 years and the Soviet Union's over 500 tests since 1949, the two nations have been able to build arsenals of 50,000 diversified nuclear weapons which now can reasonably be expected to perform as designed. If nuclear weapons explosions were stopped, the result over a period of time would be a reduction in the number of weapons fully ready for war. This gradual loss of confidence that nuclear weapons would perform as designed would discourage either side from contemplating a preemptive "first strike" attack, which requires absolute certainty weapons will work as planned. On the other hand, a retaliatory attack does not require the same high level of certainty. Thus a ban on nuclear explosions would ease the hair-trigger now set on U.S. and Soviet arsenals.

o If nuclear weapons cannot be tested new nuclear weapons cannot be developed. The importance of a ban on all nuclear explosions should not be underestimated. If a ban had been in effect for the last twenty years, the compact thermonuclear warheads that make possible multiple independently-targetable reentry vehicles (MIRV's) could never have been developed. MIRV's very seriously threaten the homeland of the U.S. and USSR and may cause either side to attempt a preemptive attack. Today, weapons designers are working on nuclear weapons which are more accurate and more suitable for use in war. Some argue that these new weapons would be safer, because they could limit the devastation of a future war. But, because they will be considered more useable, they will also make it more likely that a conventional war will quickly escalate to nuclear. Once one nuclear weapon is exploded, the likelihood is overwhelming that a global nuclear war will soon follow.

o A cessation of nuclear weapons explosions would lend much-needed credibility to the efforts of the nuclear-armed nations to halt the spread of nuclear weapons technology to non-nuclear nations. The 1968 Non-Proliferation Treaty pledges its signers "to pursue negotiations in good faith on effective measures relating to the cessation of the nuclear arms race at an early date." The most effective measure that could be achieved at this time is a ban on all nuclear explosions. Smaller nations feel, with some justice, that they, too, have a right to possess nuclear weapons, as long as the U.S. and the U.S.S.R. are engaged in an all-out nuclear arms race.

o A ban on all nuclear explosions would be the first step in a long and difficult--but absolutely essential--process of slowing, stopping and reversing the arms race. The drawback to many broad and sweeping arms control proposals is that they are often not as simple as they first appear. There are many advantages to a step-by-step approach to lessening the danger of nuclear war. Thus, logical steps to follow a ban on nuclear explosions might be a similar ban on the flight testing of new nuclear weapons delivery systems, followed by a ban on the deployment of new nuclear delivery vehicles.

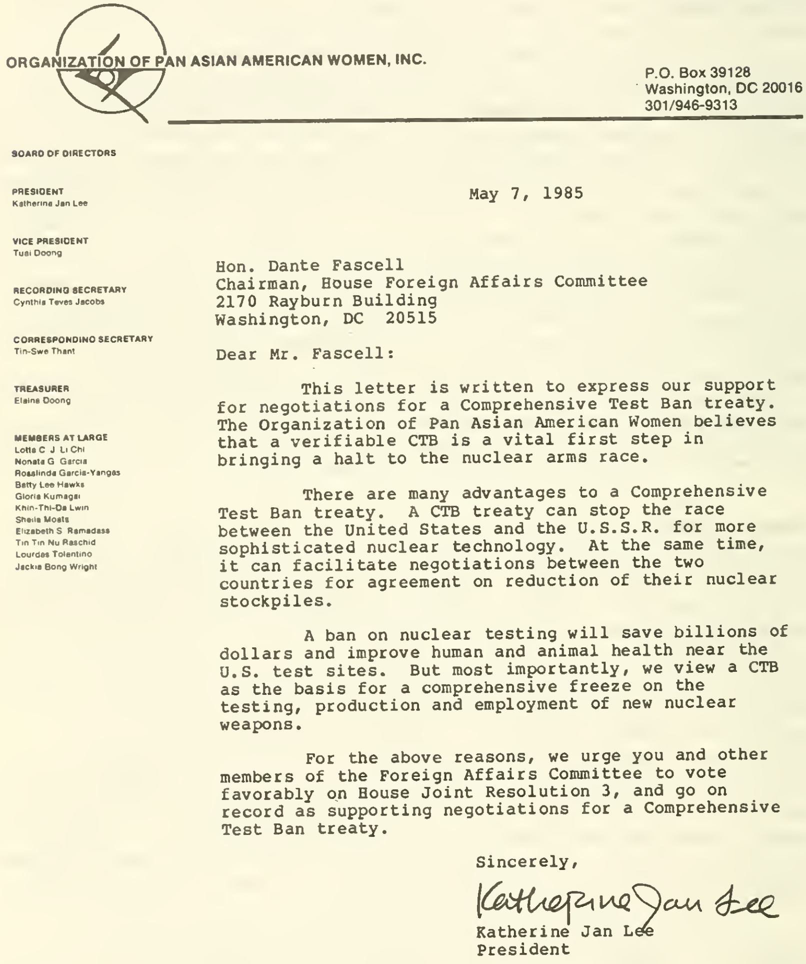
If there were no means of ensuring that all nations had ceased to explode nuclear weapons, a total test ban might entail an element of risk. But scientific advances have made it possible to detect nuclear explosions down to sizes that are militarily insignificant. Eminent seismologists state that they can now detect, locate and identify a nuclear explosion as low as one kiloton or less. There are known cases of one kiloton explosions being identified at distances of more than 2,000 miles. Preliminary steps towards additional verification guarantees were taken during talks carried out between the U.S., the U.S.S.R. and the United Kingdom beginning in 1977. The measures discussed included: installing networks of seismic monitoring stations in each other countries, agreement in principle on voluntary on-site inspections to resolve suspicious events, and an international exchange of testing information. An end to all nuclear explosions can be confidently verified under a formal treaty based on the principles already agreed to during those discussions. Certainly it is desirable to continue talking with negotiators from the Soviet Union in order to refine these verification procedures.

With these advances in monitoring capabilities, we see no reason to delay further negotiation of a Comprehensive Test Ban Treaty. We therefore strongly urge passage of H.J. Res 3.

Captain James T. Bush
Associate Director, Center for Defense Information
Washington, D. C.

APPENDIX 39

Statement From Organization of Pan Asian American Women, Inc. in Support of H.J. Res. 3



ORGANIZATION OF PAN ASIAN AMERICAN WOMEN, INC.

P.O. Box 39128
Washington, DC 20016
301/946-9313

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Lourdes Tolentino
Jackie Bong Wright

May 7, 1985

Hon. Dante Fascell
Chairman, House Foreign Affairs Committee
2170 Rayburn Building
Washington, DC 20515

Dear Mr. Fascell:

This letter is written to express our support for negotiations for a Comprehensive Test Ban treaty. The Organization of Pan Asian American Women believes that a verifiable CTB is a vital first step in bringing a halt to the nuclear arms race.

There are many advantages to a Comprehensive Test Ban treaty. A CTB treaty can stop the race between the United States and the U.S.S.R. for more sophisticated nuclear technology. At the same time, it can facilitate negotiations between the two countries for agreement on reduction of their nuclear stockpiles.

A ban on nuclear testing will save billions of dollars and improve human and animal health near the U.S. test sites. But most importantly, we view a CTB as the basis for a comprehensive freeze on the testing, production and employment of new nuclear weapons.

For the above reasons, we urge you and other members of the Foreign Affairs Committee to vote favorably on House Joint Resolution 3, and go on record as supporting negotiations for a Comprehensive Test Ban treaty.

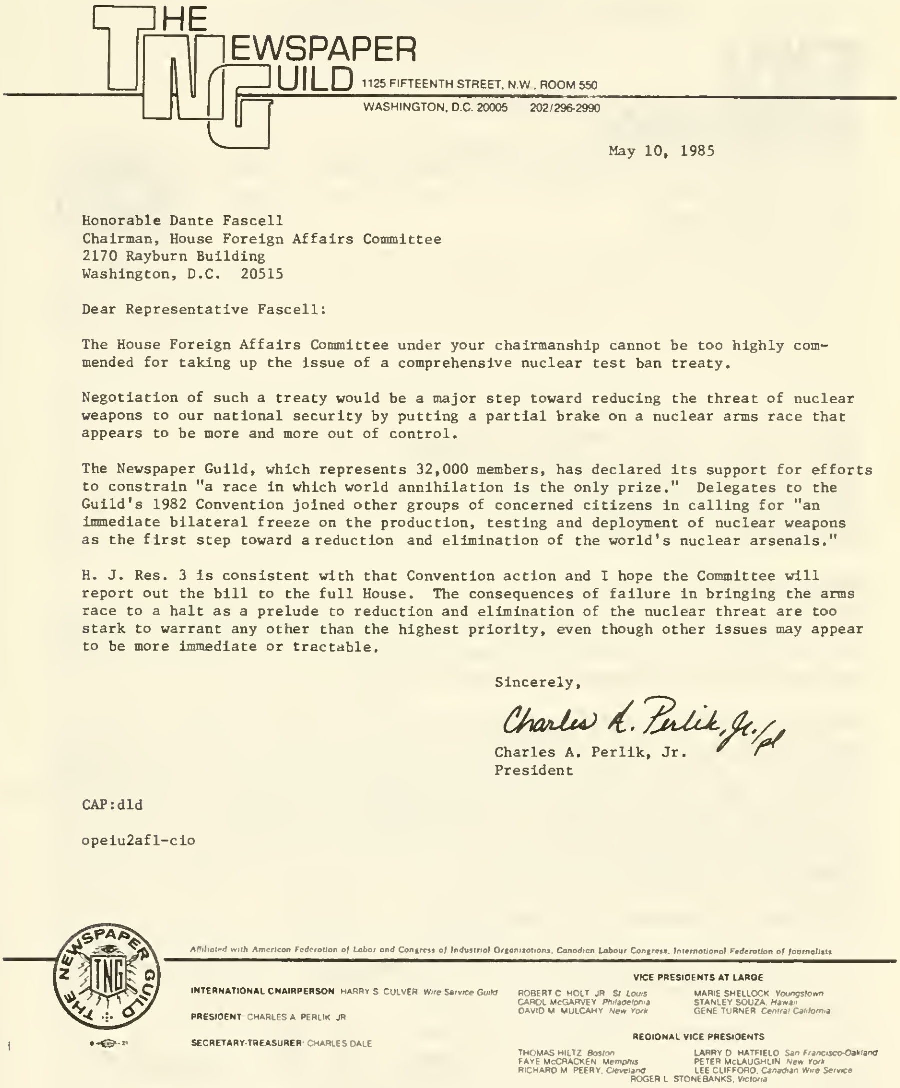
Sincerely,

Katherine Jan Lee

Katherine Jan Lee
President

APPENDIX 40

STATEMENT FROM THE NEWSPAPER GUILD IN SUPPORT OF H.J. RES. 3



THE NEWSPAPER GUILD
1125 FIFTEENTH STREET, N.W., ROOM 550
WASHINGTON, D.C. 20005 202/296-2990

May 10, 1985

Honorable Dante Fascell
Chairman, House Foreign Affairs Committee
2170 Rayburn Building
Washington, D.C. 20515

Dear Representative Fascell:

The House Foreign Affairs Committee under your chairmanship cannot be too highly commended for taking up the issue of a comprehensive nuclear test ban treaty.

Negotiation of such a treaty would be a major step toward reducing the threat of nuclear weapons to our national security by putting a partial brake on a nuclear arms race that appears to be more and more out of control.

The Newspaper Guild, which represents 32,000 members, has declared its support for efforts to constrain "a race in which world annihilation is the only prize." Delegates to the Guild's 1982 Convention joined other groups of concerned citizens in calling for "an immediate bilateral freeze on the production, testing and deployment of nuclear weapons as the first step toward a reduction and elimination of the world's nuclear arsenals."

H. J. Res. 3 is consistent with that Convention action and I hope the Committee will report out the bill to the full House. The consequences of failure in bringing the arms race to a halt as a prelude to reduction and elimination of the nuclear threat are too stark to warrant any other than the highest priority, even though other issues may appear to be more immediate or tractable.

Sincerely,

Charles A. Perlik, Jr./pl

Charles A. Perlik, Jr.
President

CAP:dld

opeiu2afl-cio

Affiliated with American Federation of Labor and Congress of Industrial Organizations, Canadian Labour Congress, International Federation of Journalists

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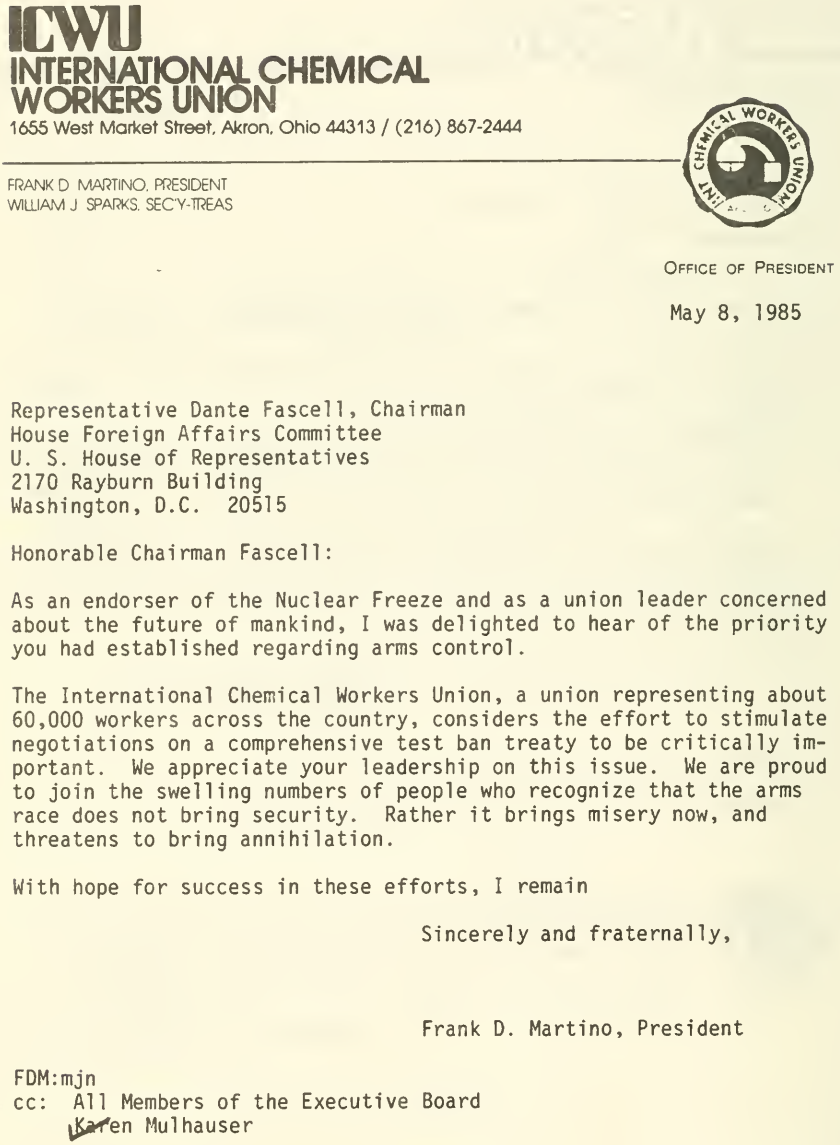
APPENDIX 41

STATEMENT FROM INTERNATIONAL CHEMICAL WORKERS UNION IN SUPPORT OF A CTB



ICWU
INTERNATIONAL CHEMICAL
WORKERS UNION
1655 West Market Street, Akron, Ohio 44313 / (216) 867-2444

FRANK D. MARTINO, PRESIDENT
WILLIAM J. SPARKS, SEC'Y-TREAS

OFFICE OF PRESIDENT

May 8, 1985

Representative Dante Fascell, Chairman
House Foreign Affairs Committee
U. S. House of Representatives
2170 Rayburn Building
Washington, D.C. 20515

Honorable Chairman Fascell:

As an endorser of the Nuclear Freeze and as a union leader concerned about the future of mankind, I was delighted to hear of the priority you had established regarding arms control.

The International Chemical Workers Union, a union representing about 60,000 workers across the country, considers the effort to stimulate negotiations on a comprehensive test ban treaty to be critically important. We appreciate your leadership on this issue. We are proud to join the swelling numbers of people who recognize that the arms race does not bring security. Rather it brings misery now, and threatens to bring annihilation.

With hope for success in these efforts, I remain

Sincerely and fraternally,

Frank D. Martino, President

FDM:mjn
cc: All Members of the Executive Board
Karen Mulhauser

APPENDIX 42

STATEMENT FROM JACK F. EVERNDEN IN SUPPORT OF H.J. RES. 3

Testimony to House Foreign Affairs Committee
Subcommittee on Arms Control

April 1985
Jack F. Evernden

Though employed by the U. S. Geological Survey, I am speaking today as a private citizen. Thus, the views I will express are mine alone and are not to be construed as those of either the U. S. Geological Survey or the U. S. Government.

I will discuss briefly two seismological topics; estimated yields of Soviet explosions since the Yield Threshold Treaty, and present state of seismological understanding relative to monitoring of a Comprehensive Test Ban Treaty or a Low Threshold Test Ban Treaty.

I know of no serious students of the subject of estimating explosive yields from seismic signals who believe there to be any evidence of Soviet violation of the Yield Threshold Test Ban Treaty. Let me give a few details which support this assertion:

a--- Livermore National Laboratories has widely announced its scientific opinion that there is no evidence of Soviet violation of the YTTBT. Both Michael May and Warren Heckrotte of Livermore Laboratories can provide you with letters expressing this view. These people have full access to all classified data and analysis and their conclusions derive from such access.

b--- DARPA contractors agree with this position. Recent papers given at DARPA conferences agree totally with the view that no recent explosions by the USSR have exceeded 150 kilotons. I have given your committee the names of some US seismologists who support the statements above. The views of one such scientist are quoted on page 22 of the document discussed in "f" below.

c--- In 1976, the technical-scientific group in the USG actually responsible for monitoring the Soviet testing program had conducted the careful analysis necessary to relate size of seismic signal to yield for Soviet explosions. That analysis, when used to estimate yields of more recent Soviet explosions, indicates that no recent Soviet tests have exceeded 150 kilotons. However, as the result of the history sketched in (f) below, this group has been forced to use too low a magnitude bias between Nevada Test Site and Semipalatinsk when reporting estimated yields of Soviet explosions, thus reporting yields a factor of two or more too high. I am certain, based upon their presentation a few years ago, that they do not believe the yield values they are now submitting.

d--- The only apparently contrary seismological evidence was presented by DARPA at the 1983 Baltimore meeting of the AAAS, the data used having been based, not on refined analysis, but on the preliminary data analysis of the U. S. Geological Survey, a source of event parameters not intended by its authors to be definitive as regards such delicate matters as magnitude estimation. Lynn Sykes and others have shown that the events in the DARPA list which were interpreted by DARPA as having yields in excess of 150 kilotons actually were of no greater yield than the other large post-YTTBT Semipalatinsk explosions, all being calculated as very near 150 kilotons. It may be useful to remember that the data used by DARPA at that AAAS meeting implied that a

US explosion of 270 kilotons or so had been exploded since the YTTBT. Thus, the data used by DARPA implied either that both the US and USSR had cheated on the YTTBT or that there was no basis in the data for accusing either one of the countries of cheating.

e--- There are no other US groups who have carefully studied this problem.

f--- In 1976-77, I was a consultant to ACDA and submitted to them an unclassified document for use in inter-agency discussions on the subject of estimating yields of Soviet explosions. That document, a copy of which I have submitted to your Committee, establishes that previously used procedures by the USG for estimating yields of Soviet explosions overestimated such yields by factors of 3 or more, depending upon the yield. That paper, together with other analysis noted above, forced acceptance by the USG of the fact that Soviet yields had always been overestimated. However, for vague and uncertain reasons, the decision of that inter-agency committee was to adjust previous estimates of yield by only a factor of about 2, rather than the factor of about four as required by analysis.

f--- At least as early as 1965, the view was widely expressed in the weapon laboratories that the pattern of seismologically estimated yields of Soviet underground explosions was uninterpretable in terms of a rational test program. It was stated by Lawrence Laboratory that Soviet testing would be understandable only if all predicted yields were divided by a factor of three or more. The agency submitting the estimated yields was asked if it was possibly in error in its estimates. It said no. It was, however, badly wrong, and has so admitted.

g--- There are non-seismological procedures for estimating yields of a few Soviet explosions, these procedures being applicable to the so-called Kama-Pechora explosions. I have been told recently that, several years prior to the YTTBT, these procedures had given estimated yields of 15 kilotons for each of the three Kama-Pechora explosions, exactly the yields I had stated in 1976 and earlier were implied by seismological analysis even though the USG said 45 kilotons. Thus, a technique totally independent of seismology long ago confirmed the fact of gross overestimation of yields of Soviet explosions. It is interesting to note that the Soviets told the US in discussions at the time of negotiation of the YTTBT that those had been 15 kiloton explosions.

One final point. The implications attached to Soviet conduct in the story leaked to Jack Anderson some years ago about the Soviets increasing yields at Semipalatinsk after the USG changed its mode of estimating yields of Soviet explosions are totally specious. The entire fabric of that tale is based on misconception or false premise. For credibility, it depends upon the following unsupportable assumptions:

Assumption 1 -- The Soviets were testing to 150 kilotons at Semipalatinsk prior to the YTTBT. There is absolutely no reason to accept this assumption in light of the known fact that the USSR conducted all higher yield explosions at Novaya Zemlya during that time. I include in the text of this testimony (and in a submitted document) a plot of Soviet testing at Semipalatinsk and Novaya Zemlya during the pertinent years. Only seismological analysis can give estimates of those pre-YTTBT yields and that analysis, acceptable to all knowledgeable authorties, says they were far below 150 kilotons, particularly just prior to the YTTBT.

Assumption 2 -- Instantaneous penetration of US security and instantaneous display of that penetration by raising yields. According to the Congressional testimony of H. DeWitt noted below, there is no rational reason for testing at yields of 300 kilotons or so if one can test to 150 kilotons. Thus, it seems unreal that such an intelligence coup would be so blatantly displayed for no technical advantage.

Assumption 3 -- The Soviets increased yields only enough to exploit the change in the US correlation of yield and seismic magnitude. As a matter of fact, magnitudes have increased by twice that amount so that an explanation of Soviet behavior since the YTTBT cannot possibly depend upon the USG's changed mode of calculating yields.

Assumotion 4 -- The Soviets would actually gain some technical advantage by executing explosions at twice the treaty threshold. My technical competence does not extend to discussion of this point. However, I will note testimony given by a qualified person. In a letter to Jeff Duncan, Staff Consultant to the Arms Control and Foreign Policy Caucus, U. S. Congress, Hugh DeWitt of Livermore Laboratories wrote: "The US stockpiles warheads with yields several times the 150 kiloton limit that have not been tested at full yield, and they don't have to be tested at full yield. The Soviets have had 36 years of experience with designing nuclear weapons, and I doubt they have any more need to test at full yield than we do...... I find Perle's assertion of an asymmetry with an advantage to the Soviets from their purported violations to be absurd."

Assumption 5 -- The close sequence in time between the adoption of new procedures by the US for estimating yields of Soviet explosions and increases in yield at Semipalatinsk were so close that there must have been a cause and effect relationship. Not true. The USG analysis was linked to entry into force of the LTTBT. The Soviet conduct may well have been linked to this event also, not to changed procedures by the USG. Thus, both US and USSR conduct may have been effects of one cause, that cause being entry into force of the YTTBT. See below.

Assumption 6. -- There is no other rational explanation of Soviet behavior at Semipalatinsk since 1976. That assumption is false as Lynn Sykes and I pointed out in the pages of SCIENCE magazine some time ago and as I point out in documents submitted to your Committee.

I conclude that all available data provide no evidence that the Soviets have tested above 150 kilotons since 1976. In fact, the data indicate clearly that they have not so tested.

As regards monitoring of a Comprehensive Test Ban Treaty or a Low Threshold Test Ban Treaty, recent analysis by myself and co-authors indicates that a comparatively slight change in monitoring procedures from those routinely used for the past 20-25 years, combined with a network exploiting these changes, can give a truly marked and critical increase in monitoring capability over that estimated in all previous studies. The essential change is to focus attention on seismic waves of higher frequency than used in the past. Because of favorable relationships between:

(1) the relative high frequency content of explosion and earthquake

signals;

(2) the relative high frequency content of explosion signals and of seismic noise;

(3) the geologic character of most of the USSR and the associated rate of dieoff of seismic signals as a function of frequency and distance; and

(4) the relative high frequency content of tamped and decoupled explosions,

a network composed of 25 or so simple (non-array) properly placed stations within the USSR augmented by a set of similar stations surrounding the USSR could successfully monitor compliance with a 1 kiloton threshold test ban treaty, even if such explosions were placed in large decoupling cavities. If your Committee should so desire, I would be most pleased to discuss these matters in detail with you or your staff.

In a recent article in SCIENCE magazine, W. J. Hannon expressed significantly more conservative views than given above. Given his point of departure for analysis and given his assumptions, I would reach nearly identical conclusions. However, I feel that several of his assumptions, his point of departure for analysis, and thus his conclusions are in serious error. I have included in the documents supplied your Committee a copy of a letter I have sent to SCIENCE rebutting numerous statements in the Hannon article. I have also given your Committee a copy of a large technical paper that discusses in detail the rationale for and the capabilities attainable through use of the new procedures mentioned above.

I would note that, from a technical point of view, a low threshold treaty set at 1 kiloton is much more advisable than a true comprehensive test ban treaty. The former could be successfully monitored, the latter could not. The former would create symmetry between the potential activities of the US and USSR at sub-kiloton yields, while the latter might lead to worrisome asymmetries. A threshold set at 1 kiloton would stop all testing relative to strategic weapons if the oft-repeated statement that the minimum critical testing level for design of strategic warheads is 5 to 10 kilotons is true. In order to ease the task of the monitoring network and to complicate that of the potential evader, I would recommend that such a low threshold treaty include a ban on decoupling and require that all treaty-permitted explosions be conducted at a specified site.

SUMMARY

In Summary, multi-discipline theory, technique and analysis have advanced to the point that

--- We can confirm that the Soviets have not tested above 150 kilotons since acceptance by the US and USSR of the Yield Threshold Treaty.

--- We can define a probably negotiable seismological network and the associated technical procedures that would allow successful monitoring at high confidence of a Yield Threshold Treaty set at a threshold of 1 kiloton.

APPENDIX 43

MINORITY VIEWS ON H.J. RES. 3

May 28, 1985

H. J. RES. 3

MINORITY VIEWS OF THE HONORABLE WILLIAM S. BROOMFIELD, HONORABLE ROBERT J. LAGOMARSINO, HONORABLE HENRY J. HYDE, HONORABLE GERALD B. H. SOLOMON, HONORABLE DOUG BEREUTER, HONORABLE MARK D. SILJANDER, HONORABLE ROBERT K. DORNAN, HONORABLE CONNIE MACK, HONORABLE MICHAEL DEWINE, AND THE HONORABLE DAN BURTON

We all welcome a way to achieve effective arms control and to prevent the nightmare of mankind's ultimate destruction by either terrible miscalculation or by accident. In this regard, we want to emphasize that the United States is actively engaged in steps designed to reduce the outbreak of all war, including nuclear war. Our Geneva negotiating team has been discussing with the Soviets ways by which nuclear arms reductions can make a serious contribution to enhanced stability. It is our hope that the new Geneva Talks will help reduce the threat of nuclear conflict and ease the tensions which exist between the superpowers.

In our haste to reduce the possibility of war, we must be careful that our actions do not increase the odds of it happening. All too often, our anxiety to reach or endorse an agreement, for agreement's sake, has been a dangerous thread running through the course of diplomatic history. Although some will say that approving arms control agreements, including test ban treaties, is simply a matter of political will, we believe that most arms control issues are highly complex and must be realistically appraised for diplomatic and technical reasons. With this in mind, it is distressing that this Committee approved H.J.Res. 3, which instructs the President not only to request advice and consent of the Senate to ratification of the Threshold Test Ban (TTBT) and Peaceful Nuclear Explosion Treaties (PNET) but also to propose to the Soviet Union the immediate resumption of negotiations toward conclusion of a Comprehensive Test Ban Treaty (CTB).

A major disagreement which we have with H.J.Res. 3 is its emphasis upon instructions for an immediate resumption of Comprehensive Test Ban talks with the Soviet Union. We remind our colleagues that Jimmy Carter cut off Comprehensive Test Ban negotiations with the Soviets for various reasons, among them being the Soviet invasion of Afghanistan. Given the continued Soviet occupation of Afghanistan, The Soviet shoot down of the Korean airliner, the Soviet killing of an American military officer, Soviet non-compliance with arms control agreements including the Limited Test Ban and Threshold Test Ban Agreements as well as persisting questions over verification technologies, we truly wonder why this Committee rushed to approve H.J.Res. 3. We also believe that meaningful arms reduction agreements, which this Administration is pursuing in the new Geneva Talks, should precede restrictions on nuclear testing, and not the other way around.

In proposing new Comprehensive Test Ban negotiations, Ambassador Walter Stoessel, our former negotiator of the Threshold Test Ban agreement and a chief witness on this difficult matter of test bans, stated before the Arms Control Subcommittee that," I feel that uncertainties concerning verification technology, plus the Soviet record of violations make it inadvisable to proceed immediately to bilateral - or resumed trilateral with the United Kindom - negotiations for a CTB with the Soviet Union." Moreover, certain respected scientists believe that by testing at such levels to be unobservable under a Comprehensive Test Ban the Soviet Union could conduct nuclear tests that are necessary to maintain confidence in its nuclear weapons stockpile while the United States, given the nature of its society, could not. Such a situation could not only result in certain nuclear force asymmetries but also in the United States being unable to confidently assure our effective counter-strike, thus negatively impacting upon our present deterrent strategy of mutual assured destruction.

Scientists have also told us that tests have been and continue to be necessary to make nuclear weapons safer in order to better protect American lives by confounding terrorist activity. Most importantly, in testimony before the Arms Control Subcommittee, Dr. Donald Kerr, the Director of Los Alamos National Laboratory, expressed verification concerns over test bans stating that "it is possible to disguise tests of relatively large nuclear weapons to make them appear (to remote monitors) relatively small or as something other than a nuclear test by exploding a device inside a hollow underground cavity." In this case, most of the energy from the explosion is not "coupled" into the earth and does not initiate seismic signals. Moreover, Dr. Kerr pointed out that there has been at least one occasion where a Soviet test, which the United States knew about, was not detected seismically.

In this regard, we believe that verification is not just some detail - it is at the very heart of arms control agreements including test ban treaties. Among other things, H.J.Res. 3 instructs the President to request advice and consent of the Senate to ratify the Threshold Test Ban Treaty, which some argue is verifiable because the agreement calls for an exchange of data between the United States and the Soviet Union. Ambassador Stoessel has strongly maintained that: "On the technical side, there is continuing controversy regarding our ability to verify with sufficient accuracy the yields of nuclear explosins in the Soviet Union. While experts differ, many maintain that without direct, on-site inspection, it is impossible to obtain adequate verification, and they hold that this would be the case even with the exchange of data provided for in the TTBT.

They note, too, that these data are to be provided from each side's sources, and they claim that - given the record of Soviet violations as likely violations of arms control agreements - this is reason to question the reliablity of such data." Moreover, Dr. Kerr testified that it is not obvious how Soviet data, relating to the TTBT, would serve significantly to reduce yield measurement uncertainties. At this time time, given current technologies and a lack of Soviet cooperation, we are forced to infer yields from seismic signals resulting from a nuclear weapons test, and there is uncertainty in our inferences. We can only say with a certain probability - but no certainty - that a given test did not exceed the 150 kt threshold.

To improve verification of the TTBT, Dr. Robert Barker, of the Arms Control and Disarmament Agency, has pointed out that the United States has sought on a number of occasions to engage the Soviets in discussions on this matter. In addition, President Reagan, in his address to the United Nations General Assembly on September 24, 1984, proposed an exchange of visits to allow Soviet experts to come to the U.S. nuclear test site and U.S. experts to go to a Soviet nuclear test site to measure directly the yields of nuclear weapons tests. Unfortunately, the Soviets have thus far rejected all our proposals to improve verification of the Threshold Test Ban.

By indicating that current nuclear testing verification technologies have limitations does not mean that all nuclear testing restraints will remain unverifiable forever. It does mean, however, that test bans, at least at this very time, would be difficult, if not impossible, to enforce. As a result, serious work needs to be devoted to new and improved technologies, which our national laboratories are now doing. It also means that the Soviet Union must be more cooperative in the arms control process, let alone in specific arrangements to augment verification. We believe that once verification technologies prove more effective, once we strenghten those arms agreements already in place, and when we have sufficiently reduced our dependence upon nuclear weapons, test bans can be more fully endorsed.

If anything, we believe that this Committee should be doing more to encourage improvements in technical verification capabilites while supporting U.S. efforts to gain agreement by the Soviet Union to measures which would substantially improve verification of test bans. We believe that such Congressional support is not lost on the Soviets. Regrettably, what we see in H.J.Res. 3 is not substantive policy, but superfluous politics.

Bill Broomfield
WILLIAM S. BROOMFIELD

Robert J Lagomarsino
ROBERT J. LAGOMARSINO

Mark D Siljander
MARK D. SILJANDER

Dan Burton
DAN BURTON

Doug Bereuter
DOUG BEREUTER

Henry J Hyde
HENRY J. HYDE

Robert K. Dornan
ROBERT K. DORNAN

Connie Mack
CONNIE MACK

Mike DeWine
MICHAEL DEWINE

Jerry Solomon
GERALD B. H. SOLOMON

APPENDIX 44

ARTICLE FROM FEBRUARY 26, 1983, ISSUE OF PENINSULA TIMES TRIBUNE ENTITLED "LIVERMORE PHYSICIST SAYS SOVIET UNION NOT VIOLATING NUCLEAR TEST BAN TREATIES"

[From the Peninsula Times Tribune, Palo Alto, CA, Feb. 26, 1983]

LIVERMORE PHYSICIST SAYS SOVIET UNION NOT VIOLATING NUCLEAR TEST BAN TREATIES

(By Mary Madison)

STANFORD—Hugh DeWitt, a physicist at the Lawrence Livermore Laboratory for the past 25 years, said this week that the Soviet Union has not been violating nuclear test ban treaties as the Reagan administration maintains.

As a result of the administration falsely accusing the Soviets, the U.S. weapons establishment is allowed to continue its own testing of nuclear bombs, and a nuclear test ban remains an impossible goal, he said.

DeWitt is one of a handful of scientists at the Livermore lab who have spoken out during the last 10 years against government nuclear weapons policies.

He told about 100 students and faculty members meeting in Stanford University's applied physics lecture hall that "the Reagan administration has been selling the American people a bill of goods, and this has been confirmed by capable people at the Livermore lab."

Although information about Soviet testing is top secret, DeWitt said that Michael May, associate director-at-large at the Livermore lab, had openly responded in the negative to a question about Soviet testing. The remark was made earlier this month at a meeting of scientists in Chicago, he said.

When asked if classified documents "conclude that there was no evidence that the Soviets had cheated on the Threshold Test Ban Treaty," May answered, "No," according to DeWitt.

The exchange involving May is reported in the March issue of the Bulletin of Atomic Scientists, now being mailed to subscribers.

DeWitt said American scientists using the latest seismological techniques have confirmed the Soviets are not conducting tests on nuclear weapons above ground.

Our seismic verification capability is so good that we can detect a test explosion down to two kilotons (2,000 tons of TNT), which is very small," he said.

"Even if the Russians try to mask explosions in cavities in Siberia, we can tell," he said.

DeWitt said the Reagan administration is pretending the Soviets are testing weapons to convince Americans it is necessary to continue testing U.S. weapons.

"Most people in the Livermore lab feel that nuclear testing is essential, and they want to have it continued," he explained.

"Making nuclear bombs is a very profitable activity and a lifetime career for the weaponeers," he said. "They're proud of it."

DeWitt said the proposed Livermore lab budget was boosted by 10 percent for 1984–85 to a total of $254.9 million.

"Lawrence Livermore is the only national laboratory that had no layoffs this year, and it's hiring right now," he said.

"Americans are moving far faster in bomb design than the Russians are at the present time," he added.

Supporters of nuclear weapons systems also want to continue testing their devices because they claim the bombs are so sensitive it is necessary to be sure materials don't deteriorate over time and cause "duds."

"It is my contention that it is possible to have nuclear bomb designs that will explode just as well in 1990 as in 1960," DeWitt said, "but it's difficult to challenge this because all the information on it is classified."

DeWitt and other concerned Livermore scientists asked the University of California Scientific and Academic Advisory Committee to look into the question of whether it is really necessary to continue testing bombs.

However, the UC committee refused to take up the matter, and UC President David Saxon also turned down a request to consider the question scientifically, according to DeWitt.

"It was ticklish for UC to handle, but this has a profound influence on America's position," DeWitt said. "It precludes the United States from ever having a nuclear test ban treaty."

Another threat on the nuclear scene is a whole new range of weapons, which are known as "directed energy" devices, DeWitt said.

Edward Teller, one of the developers of the hydrogen bomb and now a senior fellow at the Hoover Institution, has been saying that the United States is on the verge of a breakthrough in "defensive" nuclear weaponry, DeWitt reported.

Although information on the new weapons is highly classified, some newspaper articles have been printed about them, apparently stemming from Teller's comments, he said. The weapons, called "nuclear pump X-ray laser beams," could destroy missiles in flight.

DeWitt said the government already is pouring a large amount of money into development of the weapon. Sooner or later, the weapons establishment will be calling for tests of these devices, probably in space, he warned. If this happens, it will "abrogate our treaties against testing nuclear weapons in space," he said.

DeWitt said he plans to send material about the reliability of U.S. seismic instruments for verifying Russian tests to U.S. Sen. Alan Cranston, D-Calif. He also will discuss the situation in March when he addresses a meeting of the American Physical Society.

A 1951 graduate of Stanford, DeWitt holds a doctorate in physics from Cornell and has been a visiting professor at UC Berkeley and other schools. His field is theorectical physics, specializing in high-density plasma physics.

APPENDIX 45

OCTOBER 1978 FEDERATION OF AMERICAN SCIENTISTS ARTICLE ENTITLED "SCIENTISTS DENY STOCKPILE RELIABILITY TESTS NEEDED"

SCIENTISTS DENY STOCKPILE RELIABILITY TESTS NEEDED

Four of the most knowledgeable consultants and former employees of Los Alamos Scientific Laboratory argued in late August that the reliability of the stockpile of weapons was not a good argument against the conclusion of a comprehensive nuclear test ban. This directly contradicted the impression which opponents of the nuclear test ban have been giving Congress and others.

The letter to President Carter was drafted by Richard Garwin, co-signed by former Los Alamos Director Norris Bradbury (1945-1970) and by head of the Los Alamos Theoretical Division (1947-1973) J. Carson Mark. It was subsequently endorsed by Hans Bethe, Nobel Laureate, who has consulted for, and worked at, Los Alamos each year since World War II. Garwin himself has been consultant to Los Alamos since 1950.

The letter concludes that:

> "We believe that the Department of Energy, through its contractors and laboratories can through the measures described provide continuing assurance *for as long as may be desired* of the operability of the nuclear weapons stockpile." *(italics added)*

By contrast, newspaper reports had quoted Donald Kerr, Assistant Secretary of Energy for Defense Programs, as saying that:

> ". . . If the United States signed a comprehensive test ban treaty with the Soviet Union, it still would need to make occasional tests to check the quality of the nation's nuclear stockpile.
>
> He said in 30 years of its nuclear program, the United States made upwards of a dozen nuclear tests to check on stockpile quality."

Asked by FAS, in a telephone interview, whether the 30 tests had been "required" or only "desired," Mr. Kerr said:

> "At the times the problems were found, the tests of the corrective measures were thought to be necessary."

But he admitted there is a problem in "making a general statement" since there "might have been a requirement for AEC but not for the country as a whole." In effect, an agency might think it was "required" to test changes it had introduced because DOD insisted upon it. But whether the tests were really "required" in the sense that the country had no other solution was a matter that had not been considered in that 30 year period.

Kerr's main argument was that

> ". . . we are concerned that, given real life pressures and fallible human nature, we might, on occasion, stockpile new designs or inadequately reasoned changes in old ones and that serious unreliability could result."

He admitted that there were no weapons in stockpile which have deteriorated to the point of not functioning properly but said that evidence of corrosion and other deterioration had been found which "if unchecked" would "reduce the reliability of the weapons at some time in the future." Weapons had 15 to 25 year lifetimes according to this factor, he said.

The scientists' letter (see page 5) asserts that weapons found to have deteriorated in serious ways could simply be "remanufactured to precisely the original specifications." After all, we do not normally fire each and every bomb of a given type to check whether each will fire — instead, we test one or more and take on faith that the others, with the same specifications, will fire!

This letter was inspired, in part by newspaper reports (see "U.S. Sees No Early Nuclear Test Ban Accord," Walter Pincus, *Washington Post*, Wednesday, August 9, 1978) which seemed to indicate that opponents of the test ban were succeeding. According to that report, the Directors of the Los Alamos and Livermore Laboratories (Harold Agnew and Roger Batzel respectively) had met with the President on June 15 and had objected to a zero yield, five-year limited test ban.

Notwithstanding their objections, the Government seems still in agreement that any future test ban should not be just a still lower threshold agreement (than the 150 kiloton limit now in force) but should really preclude all nuclear tests. But the debate may be raging over whether the agreement should be five years or three. According to the scientists' letter, it could be indefinite as far as stockpile reliability is concerned.

Administration Confusion

The Administration is generating some confusion on this issue. One newspaper report seemed to imply that Kerr was speaking for the Administration but, in discussions with FAS, Kerr admitted that his remarks had not been cleared with the Administration (indeed, he had spoken from notes only and typed up a "draft" statement afterward). Asked whether he had made clear that he was not speaking for a unified Administration, he said he had said he was speaking for the "Department of Energy" which, evidently, he considered to be not just an identification, but a disclaimer.

In defense of speaking out on this issue without clearance, Kerr said that DOE was a "lead agency" in the matter of testing just as State was a "lead agency" in the matter of diplomatic questions. It seems that, under the Carter Administration, agencies do not feel that they must clear statements with other agencies so long as they have primary responsibility for the subject matter at issue! — but this would make clearances pointless.

The letter to the President was released a day after it was delivered by Senator Kennedy, with the endorsement of the Federation of American Scientists. Senator Kennedy's covering statement criticized Donald Kerr for having said that without nuclear tests —

> ". . . confidence in the nuclear stockpile, in our best judgment, would degrade. Entire weapons systems would have to be deleted from the force structure, systems for which we now see no alternative . . . a total cessation of testing in the long run would inevitably result in a steady decline of our confidence

> in the reliability of our nuclear deterrent and risk a steadily growing asymmetry between US and Soviet military forces."

Kennedy said these statements not only "undercut the President's policy, but they amount to a gross misrepresentation of the implications of a CTB for our national security." He said that the "most determined advocates of nuclear testing" can be found in DOE and in its weapons labs. ☐

LETTER TO THE PRESIDENT

August 15, 1978

President Jimmy Carter
The White House
Washington, D.C. 20500

Dear Mr. President:

As individuals long involved in the conception, design, manufacture, test, and maintenance of many of the United States' nuclear and thermonuclear weapons, we want you to know of our judgment on a question which has assumed considerable prominence in connection with the Comprehensive Test Ban Treaty ("CTBT"). That is the question of the degree of assurance in the continued operability of our stockpiled nuclear weapons in the absence of any possibility of testing with significant nuclear yield (for instance, with testing limited to laboratory-type experiments.)

As you know, the assurance of continued operability of stockpiled nuclear weapons has in the past been achieved almost exclusively by non-nuclear testing — by meticulous inspection and disassembly of the components of the nuclear weapons, including their firing and fuzing equipment. Problems encountered in this inspection are normally validated by additional sampling and solved by the remanufacture of the affected components. This program is, of course, supplemented by the instrumented firing of the entire nuclear weapon with inert material replacing the fissile materials, and the entire program thus far described would be unaffected by the requirements of a CTBT. It has been exceedingly rare for a weapon to be taken from stockpile and fired "for assurance."

It has also been rare to the point of non-existence for a problem revealed by the sampling and inspection program to *require* a nuclear test for its resolution. There are three acceptable approaches to the correction of deficiencies without requiring nuclear testing:

1) Remanufacture to precisely the original specifications.
2) Remanufacture with minor modifications in surface treatment, protective coatings, and the like, after thorough review by experienced and knowledgeable individuals.
3) Replace the nuclear explosive by one which has previously been tested and accepted for stockpile.

A fourth option, to replace the troubled nuclear system by one not already prooftested may result in improved performance, lesser use of special nuclear materials, or the like, virtues which have more to do with improvement of the stockpile than with confirming its operability.

Richard L. Garwin

We believe that the key question to be answered by those responsible for making and maintaining nuclear weapons is

> "Can the continued operability of our stockpile of nuclear weapons be assured without future nuclear testing? That is, without attempting or allowing *improvement* in performance, reductions in maintenance cost, and the like, are there non-nuclear inspection and correction programs which will prevent the degradation of the reliability of stockpiled weapons?"

Our answer is "yes," and we now discuss the reasons why knowledgeable people may have answered "no" to seemingly similar questions.

First, we confined ourselves essentially to the question, "If the stockpile is not required to improve, can it be kept from degrading?" Others may have had in mind the normal work of the weapons laboratories, by which nuclear weapons are continuously made somewhat more efficient, less costly in terms of nuclear materials, adapted to new packaging requirements, and safer to handle — for instance by the substitution of insensitive explosive. We have participated in such programs and find them both interesting and useful. Were these "improvement programs" carried out long enough without nuclear testing, the weapons thus affected would indeed have uncertain performance; the solution under a CTBT would be to forego such programs in order not to sacrifice stockpile reliability to a desire for minor improvement in performance.

Second, it is true that certain deficiencies have in the past been corrected by the replacement of the affected nuclear system by another one, following a test certifying the replacement model as ready for stockpile. This corrective measure would not be available under a CTBT. But the examples normally cited need *not* have been corrected in this way; for instance one Polaris warhead problem could readily have been solved by remanufacture with an acceptable change of surface treatment on the component which had caused the problem. The change of nuclear system was not absolutely necessary for the correction of the problem observed.

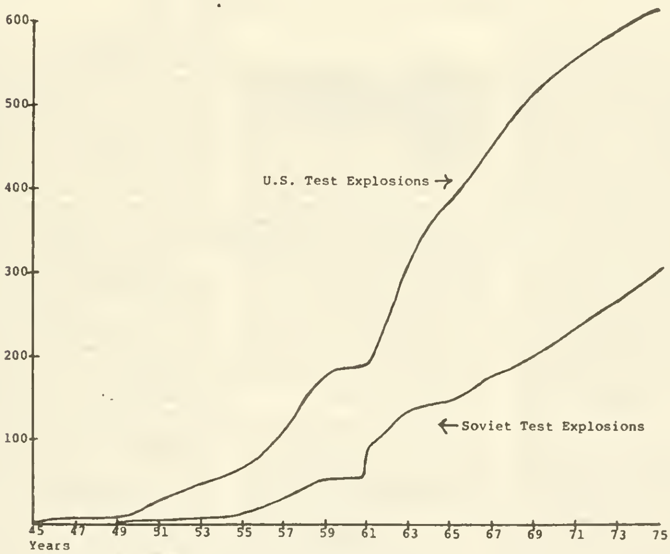
Finally, it is sometimes claimed that remanufacture may become impossible because of increasingly severe restrictions by EPA or OSHA to protect the environment of the worker. We note that additional protective measures which might be an intolerable cost burden in the manufacture of cardboard or of lightbulbs or of aircraft brakes are easily affordable in connection with the nuclear stockpile. Thus if the worker's environment acceptable until now for the use of asbestos, spray adhesives, or beryllium should be forbidden by OSHA regulations, those few workers needed to continue operations with such material could wear plastic-film suits (supplied with external air) commonly used for isolation against germs and against certain pharmaceuticals. It would be wise also to stockpile in appropriate storage facilities certain commercial materials used in weapons manufacture which might in the future disappear from the commercial scene.

It has been suggested that under a CTBT a President or Congress or the Department of Energy might not provide funds for stockpile maintenance inspection and correction, or that a President might not provide a requested exemption from OSHA or EPA requirements. We see no reason to assume that the national security bureaucracy will not continue to serve the national interest, and we would welcome a statement in conjunction with a CTBT that non-nuclear testing, inspection, and remanufacture where necessary will be fully supported in order to ensure the continued operability of stockpiled nuclear weapons.

We believe that the Department of Energy, through its contractors and laboratories, can through the measures described provide continuing assurance for as long as may be desired of the operability of the nuclear weapons stockpile. We are making this statement available to others in the Executive and the Congress.

Sincerely Yours,
Norris E. Bradbury
Richard L. Garwin
J. Carson Mark

NUCLEAR TEST EXPLOSIONS, 1945-75



SOURCE: data from SIPRI Yearbook, 1976, p. 416

APPENDIX 46

OCTOBER 1983 SCIENTIFIC AMERICAN ARTICLE ENTITLED "THE VERIFICATION OF A COMPREHENSIVE NUCLEAR TEST BAN"

The Verification of a Comprehensive Nuclear Test Ban

Networks of seismic instruments could monitor a total test ban with high reliability. Even small clandestine explosions could be identified even if extreme measures were taken to evade detection

by Lynn R. Sykes and Jack F. Evernden

Two treaties put into effect over the past 20 years have set limits on the testing of nuclear weapons. The Limited Test Ban Treaty of 1963, which has been signed by more than 120 nations, prohibits nuclear explosions in the atmosphere, the oceans and space, allowing them only underground. The Threshold Test Ban Treaty of 1976, a bilateral agreement between the U.S. and the U.S.S.R., prohibits underground tests of nuclear weapons with a yield greater than 150 kilotons. In the present climate of widespread pressure for more effective control of nuclear arms the idea of a comprehensive ban on all nuclear testing is receiving renewed attention. Such an agreement would be an important measure. It might inhibit the development of new weapons by the major nuclear powers, and it might also help to prevent the spread of nuclear-weapons technology to other countries.

A halt to all testing was the original goal of the negotiations that led to the 1963 Limited Test Ban. New talks with the aim of achieving a total ban were begun in 1977 by the U.S., the U.S.S.R. and Britain, but the talks were suspended in 1980. In both cases the main impediment to a comprehensive treaty was the contention by the U.S. and Britain that compliance with the treaty could not be verified because sufficiently small underground nuclear explosions could not be reliably detected and identified. In July the Reagan Administration announced that the test-ban negotiations with the U.S.S.R. and Britain will not be resumed. Once again the primary reason given was a lack of confidence in methods of verifying compliance.

In 1963 the reliability of measures for the verification of a treaty banning explosions larger than about one kiloton may have been arguable, but it no longer is. We address this question as seismologists who have been concerned for many years with the detection of underground explosions by seismic methods and with means of distinguishing underground explosions from earthquakes. We are certain that the state of knowledge of seismology and the techniques for monitoring seismic waves are sufficient to ensure that a feasible seismic network could soon detect a clandestine underground testing program involving explosions as small as one kiloton. In short, the technical capabilities needed to police a comprehensive test ban down to explosions of very small size unquestionably exist; the issues to be resolved are political.

An underground explosion sets up elastic vibrations that propagate as seismic waves through the earth and along its surface. The waves travel great distances, and seismic monitoring instruments in common use are sensitive enough to record even those generated by very small explosions. Once the waves have been detected the main task is to distinguish the seismic signals of explosions from those of earthquakes. This can be done with a network of several widely separated seismometers.

Two types of elastic vibrations can propagate through the solid body of the earth, that is, through the crust and the mantle. The first waves to arrive at a seismometer are compressional waves, which are similar to sound waves in air or water; the seismological name for them is *P* (for primary) waves. The slower body vibrations are shear waves, which are similar to the waves on a vibrating string; they are called *S* (for shear or secondary) waves. An underground explosion is a source of nearly pure *P* waves because it applies a uniform pressure to the walls of the cavity it creates. An earthquake, on the other hand, is generated when two blocks of the earth's crust rapidly slide past each other along the plane of a fault. Because of this shearing motion an earthquake radiates predominantly *S* waves.

A result of the spherical symmetry of the explosion source is that all the seismic waves it generates have a nearly radial symmetry around the focus of the explosion. In contrast, the highly directional character of an earthquake source gives rise to seismic waves with strongly asymmetric patterns. The asymmetry in the amplitude of the waves received at seismometers throughout the world provides the means whereby seismologists can determine the faulting mechanism of a given earthquake.

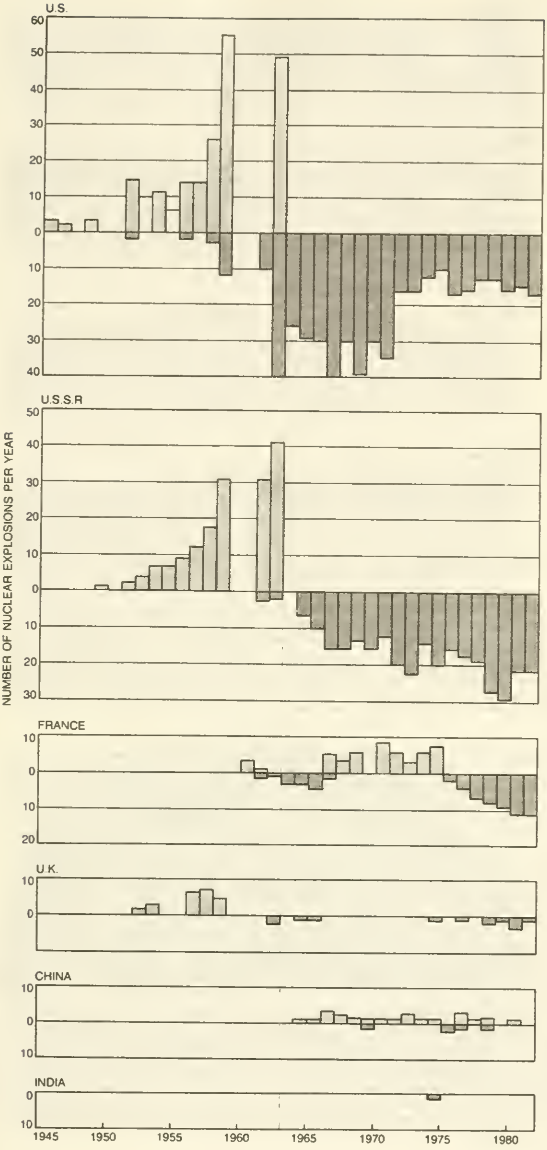
In addition to the *P* and *S* body waves there are also two types of seismic waves that propagate only over the surface of the earth. They are called Rayleigh waves and Love waves, and they result from complex reflections of part of the body-wave energy in the upper layers of the earth's crust. A simple explosion can generate Rayleigh waves but not Love waves, whereas an earthquake generates waves of both types.

Seismologists characterize the size of a seismic event by means of magnitudes. A given event can be assigned several magnitudes, each one based on a different kind of seismic wave. A magnitude is the logarithm of the amplitude of a particular type of wave normalized for distance and depth of focus. Of the numerous magnitudes that can be defined for a single seismic event we shall discuss only two, which in seismological notation are designated M_S and m_b. The former is generally based on Rayleigh waves with a period of 20 seconds, the latter on one-second *P* waves. The magnitude of a seismic signal is ultimately related to the energy released at the site of the event. For a nuclear explosion the customary measure of energy release is the yield in kilotons, where one kiloton is the energy released by detonating 1,000 tons of TNT.

Every year there are numerous earthquakes whose magnitudes are in the range corresponding to the yields of underground explosions. Several methods can be applied to several types of waves to distinguish the seismic waves of explosions from those of earthquakes. The location of a seismic event and its depth below the surface are important criteria; indeed, the great majority of routinely detected events can be classified as earthquakes simply because they are either too deep or not at a plausible site for an explosion. The remaining events can be reliably classified by the amount of energy radiated in the several kinds of waves at various frequencies.

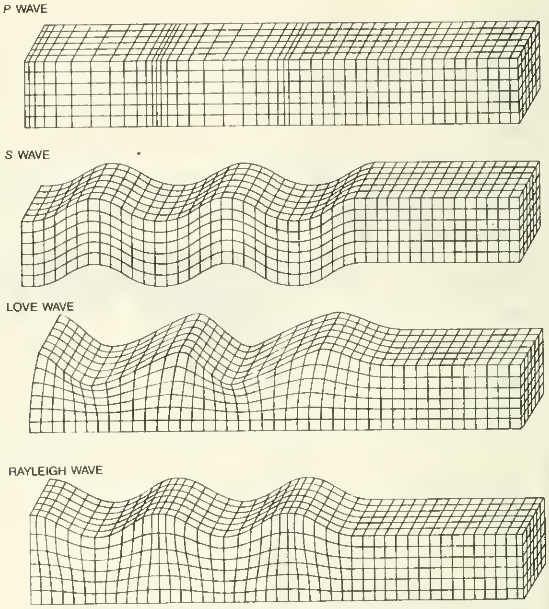
The location of an event in latitude and longitude is a powerful tool for classification. The position is determined by recording the arrival time of short-period *P* waves at several seismographic stations in various parts of the world. The travel time of the *P* waves to each station is a function of distance and depth of focus. From the arrival times it is possible to determine the location of the source with an absolute error of less than 10 to 25 kilometers if the seismic data are of high quality.

The identification of seismic events at sea is quite simple. It is assumed that the network monitoring a test-ban treaty would include a small number of simple hydroacoustic stations around the shores of the oceans and on a few critical islands to measure pressure waves in seawater. The hydroacoustic signal of an underwater explosion is so different



NUCLEAR TESTS CONTINUE to be carried out at a rate of about 50 per year, principally by the two leading nuclear-weapons powers: the U.S. and the U.S.S.R. As this bar chart shows, the main effect of the Limited Test Ban Treaty of 1963 (*broken vertical line*) was not to reduce the number of test explosions but merely to drive most of them underground. Nuclear test explosions in the atmosphere and underwater are represented by colored bars, those underground by gray bars.

from that of an earthquake and can be detected at such long range that the identification of a seismic event at sea as an explosion or an earthquake is simple and positive. Hence any event whose calculated position is at least 25 kilometers at sea (a margin allowing for errors) can be classified as an earthquake on the basis of its location and the character of its hydroacoustic signal.



FOUR TYPES OF SEISMIC WAVE are illustrated. The two waves at the top propagate through the solid body of the earth; the two at the bottom propagate only near the surface. The compressional body waves called *P* (for primary) waves travel fastest and are the first ones to arrive at a seismometer; they are the predominant type of body wave produced by an underground explosion. The slower body waves called *S* (for shear or secondary) waves vibrate in a plane transverse to their direction of propagation; they are the predominant type of body wave produced by an earthquake. The surface waves called Rayleigh waves and Love waves result from complex reflections of the *P* and *S* body waves in the upper layers of the earth's crust.

The accuracy with which the position of a seismic event can be determined in an area offshore of an island arc has been tested with an array of ocean-bottom seismometers off the Kamchatka Peninsula and the Kurile Islands in the U.S.S.R. The tests indicate that the accuracy of a seismic network under these circumstances is much better than 25 kilometers. Holding to that standard, however, one finds that well over half of the world's seismic events are definitely at sea and are therefore easily identified as earthquakes.

Another large group of detected events have their epicenters on land but in regions where no nuclear explosions are to be expected; these events too can be safely classified as earthquakes. Indeed, almost all the world's seismic activity is in regions that are of no concern for monitoring compliance with a comprehensive test ban. Thus the simple act of locating seismic events classifies most of them as earthquakes.

Calculating the depth of focus provides a means of identifying a large fraction of the remaining earthquakes. From 55 to 60 percent of the world's earthquakes are at depths of more than 30 kilometers; at least 90 percent are more than 10 kilometers deep. Any seismic event as deep as 15 kilometers is certainly an earthquake. No one has yet drilled into the earth's crust as far down as 10 kilometers, and the deepest nuclear explosions have been at a depth of about two kilometers.

Several seismological procedures can be employed to determine an event's depth of focus. In most cases the depth is calculated at the same time as the location. When a seismic event is detected at 20 stations or more, a routinely calculated depth of 30 kilometers or more ensures with a 95 percent degree of confidence that the event was at least 15 kilometers below the surface.

A powerful technique for estimating depth can be applied if at least one seismological station is within a few hundred kilometers of the detected event. (A monitoring network for a comprehensive test ban would be quite likely to meet this condition in areas where nuclear testing might be expected.) A pair of *P* and *S* waves generated at the same instant and recorded by a station near the event follow identical paths but propagate at different speeds. The difference in their times of arrival, or in other words the difference in their phases, therefore serves to determine the time of origin of the event. With experience the seismograms of a station near the event can be successfully analyzed to detect at least one pair of such *P* and *S* phases. Given the time of origin determined in this way and the arrival times of the *P* waves at only a few distant receivers, an accurate estimate of the depth of focus can be made.

There may remain critical seismic regions where nearby stations do not exist. Data from large events can then be employed to refine the calculated depth and location of smaller events. The essence of the technique is to correct the observed times of small events by noting the differences between the observed and the calculated times for a large event in the same area. The procedure is in routine use by several networks.

The combined effectiveness of location and depth in distinguishing earthquakes from explosions is impressive. More than 90 percent of all earthquakes either are under oceans or are at least 30 kilometers deep (or both). Most of the remaining earthquakes are of little interest because they are in countries that are unlikely to be testing nuclear weapons or in countries where clandestine testing would be impossible. For the U.S., of course, the U.S.S.R. is the country of prime interest. About 75 percent of the earthquakes in and near the U.S.S.R. are in the eastern part of the country near the Kamchatka Peninsula and the Kurile Islands. Almost all of the shocks in these areas either have a focal depth greater than 50 kilometers or are well offshore. It turns out that seismic events whose calculated position is on land in the U.S.S.R. or less than 25 kilometers at sea and whose calculated depth is less than 50 kilometers constitute only about .5 percent of the world's earthquakes. This amounts to about 100 earthquakes per year with an m_b magnitude greater than 3.8 for which other seismic discriminants must be employed.

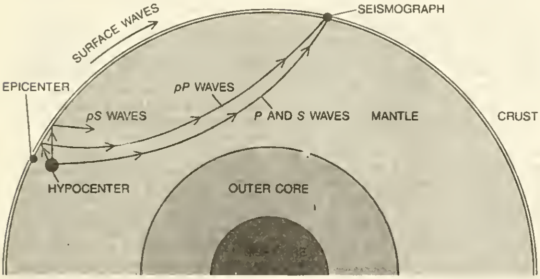
None of the measures we have discussed so far relies on the detailed characteristics of the waves radiated by earthquakes and explosions. Several powerful discriminants are based on those characteristics, in particular on the relative amounts of energy in waves of different types and periods. For example, a shallow earthquake generates 20-second Rayleigh waves with amplitudes at least several times greater than those of an explosion that releases the same amount of energy. In the notational practice of seismology the comparison of the two magnitudes is referred to as the $M_S:m_b$ ratio, that is, the ratio of long-period to short-period waves.

A second spectral discriminant is based on the observation that long-period *P* and *S* waves are rarely or never seen in association with explosions but one type or the other is routinely detected today by simple seismometers for most earthquakes that have a one-second *P*-wave magnitude of at least 4.5. More sophisticated seismic stations and more sophisticated analysis of the signals could lower the magnitude at which such waves can be detected.

A third distinction is that surface waves of the Love type are generated far more strongly by shallow earthquakes than they are by underground explosions, including even abnormal explosions. Still another characteristic feature of the seismic signal from explosions is that the first motion of the earth stimulated by *P* waves is always upward because the explosion itself is directed outward; the first *P*-wave motion in an earthquake can be either upward or downward.

An important factor contributing to the separation of earthquakes from explosions on an $M_S:m_b$ diagram is that *P* waves from the two kinds of events have different radiation patterns. Explosions radiate short-period *P* waves equally in all directions, whereas earthquakes have very asymmetric patterns. Hence most earthquake sources show a decrease of from .4 to one magnitude unit from the peak values when the *P*-wave amplitudes are averaged over pertinent radiation angles. A simple explosion does not initially radiate any shear waves; earthquakes typically generate large shear waves. As a result Rayleigh waves generated by many types of earthquakes have a larger amplitude than the corresponding waves generated by underground explosions of the same m_b.

There is a characteristic time for the formation of the source of a seismic event; the time is equal to the maximum source dimension divided by the velocity of source formation. The source dimension for earthquakes is the length of the break where most of the short-period energy is released; it is from three to 20 times greater, depending on the state of stress in the rocks, than the radius of the cavity and shatter zone of a comparable explosion. The velocity of source formation for earthquakes is from somewhat less to much less than the velocity of shear waves in the rocks surrounding the fault, whereas the relevant velocity for explosions is the velocity of shock waves in the rock, which is essentially the velocity of compressional waves. As a result of these differences in the size of the source and the velocity of source formation the characteristic times for earthquakes and explosions differ by a factor of from six to 40. It is therefore not surprising that differences are observed between the short-period *P*-wave spectra of earthquakes and explosions.



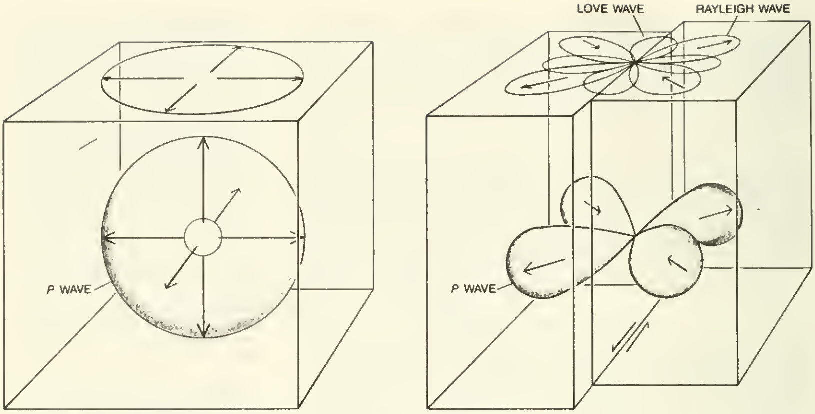
PATHS OF SEISMIC WAVES are traced on a cross section of the earth. Body waves from an earthquake or an explosion travel through the crust and mantle along the curved paths labeled *P*, *S*, *pP* and *pS*. A *pP* wave is a compressional wave that is produced by the reflection of a *P* wave from the surface of the earth just above an earthquake or an explosion; a *pS* wave is a shear wave that results from the conversion of part of the compressional energy of an upward *P* wave into transverse energy as the *P* wave is reflected from the surface. Surface waves such as Rayleigh waves and Love waves diminish rapidly in amplitude with increasing depth. The hypocenter is the focal point of an earthquake or an underground explosion from which the waves radiate. The epicenter is the point on the earth's surface directly over the hypocenter.

Observations of several U.S. explosions have demonstrated the existence of a phenomenon called overshoot. It is related to shock waves in strong rock, but it can be thought of as the equivalent of cavity pressure rising to high values followed by a decrease in pressure by a factor of four or five; the lower pressure is then maintained for many tens of seconds. Overshoot, when it occurs, provides additional *P*-wave spectral discrimination and augments discrimination by means of the $M_S:m_b$ ratio for larger events.

It was once thought that an explosion could not give rise to any Love waves at all. A phenomenon that was of great significance in thwarting President Kennedy's effort to achieve a comprehensive test-ban treaty in 1963 was the observation that many underground nuclear explosions at the U.S. testing site in Nevada, particularly those in hard rock, generated unmistakable Love waves. The failure of the qualitative criterion "No Love waves from explosions" (at a time when such quantitative criteria as the comparison of the magnitudes of long-period and short-period waves were not adequately established) left seismologists unable to guarantee their ability to distinguish the seismic waves of underground explosions from those of earthquakes.

The presence of Love waves in the Nevada tests has since been explained. What was not considered in the earlier analyses was the influence of the natural stressed state of the earth on the waves generated by an explosion. The creation of a cavity and its surrounding shatter cone by an underground explosion leads to the release of some of the natural stress, which in turn generates seismic waves equivalent to those of a small earthquake, including Love waves. The observed waves are a superposition of the waves from the explosion and from the release of the stress.

The release of natural stress also alters the amplitude of Rayleigh waves. The perturbation has never been large enough, however, to put in doubt the nature of an event identified by the ratio of long-period to short-period waves. Only rarely does the perturbation significantly affect the amplitude of *P* waves; it is not known ever to have changed the direction of their first motion. Moreover, if the magnitude M_S is determined from Love waves rather than Rayleigh waves, the ratio method ($M_S:m_b$) provides an excellent discriminant.



RADIATION PATTERNS of the *P* waves resulting from an underground explosion (*left*) and an earthquake (*right*) are compared. The first motion of the *P* waves from an explosion is uniformly outward and hence is generally observed as an upward displacement at all seismic stations. The first motion of the *P* waves from an earthquake is outward in some directions and inward in others; the pattern of the waves at the surface depends on the orientation of the plane of the earthquake fault. In the comparatively simple case of a vertical strike-slip fault, shown here, the four-lobed radiation pattern observed at the surface for both *P* waves and Rayleigh waves is a simple projection of the three-dimensional *P*-wave configuration emanating from the hypocenter of the earthquake. The radiation pattern of the Love waves emitted by the same source is rotated by 45 degrees with respect to the surface pattern of the *P* waves and the Rayleigh waves.

In short, if seismologists had done their homework thoroughly by 1963, the nations of the world might well have achieved a comprehensive test-ban treaty then. Today the release of natural stresses in the earth is significant only as a perturbing factor that must be taken into account when the yield of an explosion is estimated from Rayleigh waves.

Reports that earthquakes occasionally have $M_S : m_b$ values like those of explosions have been cited as a factor that might impede the effective monitoring of a comprehensive test ban. In analyzing a large set of earthquakes in all parts of the world and of underground explosions in the U.S. and the U.S.S.R. we found only one example of this kind of ambiguity. The focus of the event was far from the area in which the seismometer network gave its best results.

In 1972, at a meeting of the UN Committee on Disarmament, the U.S. submitted a list of 25 "anomalous" events that were said to be indicative of a problem in discrimination. In 1976 the 25 events were reanalyzed by one of us (Sykes) and two other seismologists, Robert Tathum and Donald Forsythe. It was established that about half of the events had $M_S : m_b$ values that put them clearly in the earthquake population. Most of the original magnitudes had been determined from only one or two stations, and much existing information had not even been consulted. When the records of other available stations were examined, the events ceased to be "anomalous."

For the remaining problem events $M_S : m_b$ measurements based on 20-second Rayleigh waves gave values in the range characteristic of explosions. Several of these events were at depths of from 25 to 50 kilometers, where the possibility of nuclear testing can be excluded in any case, but the magnitude ratio nonetheless demanded explanation. It is known from seismological theory that certain types of earthquakes at these depths excite long-period Rayleigh waves poorly. The theory predicts, however, that Love waves and vibrations called higher-mode Rayleigh waves are in many instances vigorously generated in these circumstances. An analysis of recordings of the Love waves and the higher-mode Rayleigh waves identified several more of the problem events as earthquakes.

Only a single sequence of events at one place in Tibet remained as a problem. In that region underground nuclear testing is unlikely, but the nature of the events could not be determined with certainty from the magnitude ratios. We think the reason is that with the seismographic networks of the 1960's, when the events were recorded, Love waves could not be detected for small-magnitude events because they were obscured by background earth noise. New installations and new modes of data processing have greatly reduced the problem. If the same series of events or a similar series were to take place today, we think they would be identified unambiguously. Long-period seismographs in boreholes and routine digital processing of seismograms lead to a suppression of background noise and increase the detectability of many types of waves, including Love waves.

As it happened, the nature of the Tibetan problem sequence was resolved in spite of the inadequacies of the long-period data of the time. At several stations the first motion of the *P* waves was downward, which is not possible for an explosion. Hence the events must have been small earthquakes.

It seems reasonable to say that for the networks we shall describe below there should no longer be any problem events at m_b 4 or more. We know of no Eurasian earthquake with a one-second *P*-wave magnitude of 4 or more in the past 20 years whose waves are classified as those of an explosion. (Of course, numerous smaller Eurasian earthquakes during that period went unidentified because of inadequate data.) Furthermore, to our knowledge not one out of several hundred underground nuclear explosions set off in the same period radiated seismic waves that could be mistaken for those of an earthquake. Our experience indicates an extremely low probability that an event will remain unidentified when all the available techniques of discrimination are brought to bear.

No monitoring technology can offer an absolute assurance that even the smallest illicit explosion would be detected. We presume that an ability to detect and identify events whose seismic magnitude is equivalent to an explosive yield of about one kiloton would be adequate. It is often assumed that for the U.S. to subscribe to a comprehensive test ban it would require 90 percent confidence of detecting any violation by another party to the treaty. Developing a new nuclear weapon, however, generally requires a series of tests, and the probability that at least one explosion will be detected rises sharply as the number of the tests is increased. Moreover, a 90 percent level of confidence for the detection of even a single explosion probably is not needed. For a country seeking to evade the treaty the expected probability of detection would certainly have to be less than 30 percent, and perhaps much less, even if only one illicit test were planned. The test-ban agreements that have been considered over the years all include an "escape clause" through which a country could renounce its treaty obligations. Unless the probability of detection were very low, a country whose national interest seemed to demand a resumption of testing would presumably invoke the escape clause rather than risk being caught cheating.

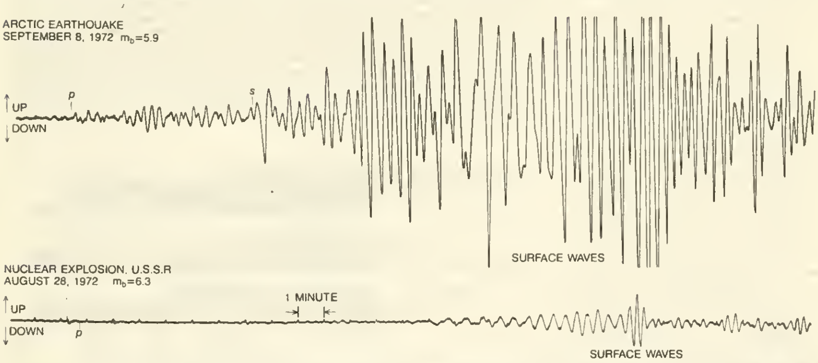
Given these standards of reliability for a monitoring system, it is possible to specify the size and the sensitivity of the seismic network that would be needed to verify compliance with a comprehensive test ban. Two kinds of network can be considered for maintaining seismic surveillance of the U.S.S.R. One network consists of 15 stations outside the borders of the U.S.S.R. In the second network the 15 external stations are supplemented by 15 internal ones.

The ultimate limit on the detection of seismic signals is imposed by microseisms, or random vibrations of the earth's surface. Most microseisms are induced by the earth's atmosphere and oceans. In order to detect a one-kiloton explosion in much of the U.S.S.R. a monitoring network would have to be able to recognize above the background noise any event with a short-period P-wave magnitude of 3.8 or more. In order to distinguish an explosion from an earthquake by comparing the long-period magnitude with the short-period one, the network would also have to be able to detect surface waves with an M_S magnitude of 2.5 or more. The network of 15 external stations could achieve these goals. Indeed, since almost all the seismic areas of the U.S.S.R. are along its borders, the external network would be sensitive to events of even smaller magnitude there. The mere detection of a seismic event in most areas of the interior would constitute identification of the event as an explosion.

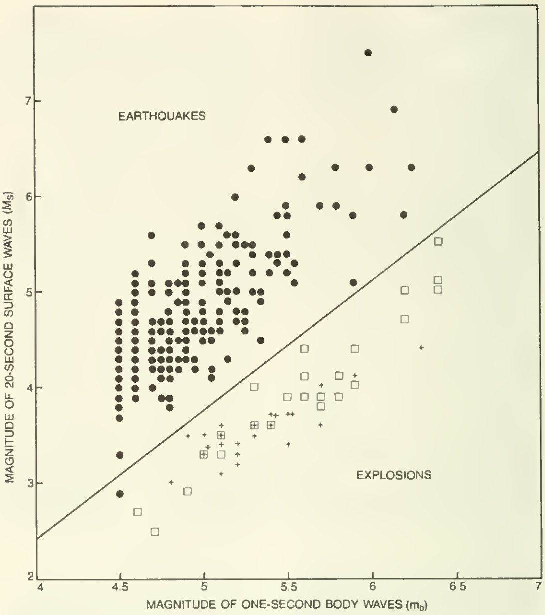
The lower limit of one kiloton on the yield of an explosion that could be detected by an external network is based on the assumption that the coupling between the explosion and the seismic radiation is efficient and that the explosion was not set off during or soon after a large earthquake. If one must consider the possibility that a country would try to evade a test-ban treaty by decoupling, or muffling, an explosion and thereby reducing the amplitude of the emitted seismic signals, an improved network would be required. In principle such muffling could be done by detonating the explosion in a large cavity or by using energy-absorbing material in a smaller cavity. The former stratagem might reduce the seismic signal of an explosion by 1.9 magnitude units as measured by one-second P waves (that is, by m_b). The latter stratagem might bring a reduction of one unit.

The use of an oversize cavity is clearly the more worrisome possibility, but it could be attempted only in certain geologic formations: a salt dome or a thick sequence of bedded salt deposits. Few areas of the U.S.S.R. have deposits of salt in which the construction of a cavity large enough for decoupling a several-kiloton explosion would be possible. The maximum size of a cavity that could reasonably be constructed and maintained sets a limit of two kilotons on explosions that might be muffled in this way and escape detection by the 15-station external network.

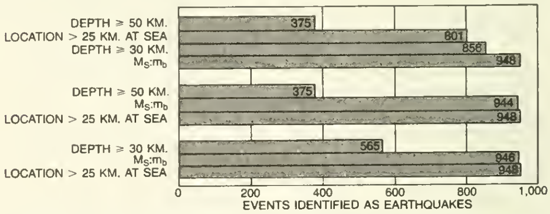
Another way to reduce the amplitude of radiated seismic waves is by detonating an explosion in a low-coupling medium such as dry alluvium. The maximum thickness of dry alluvium in the U.S.S.R. sets a limit of 10 kilotons on explosions that might be concealed by this means, again assuming that only the 15 external stations were installed.



SEISMOGRAMS OF LONG-PERIOD WAVES from an earthquake in the Arctic near the U.S.S.R. (*top*) and an underground nuclear explosion in the U.S.S.R. (*bottom*) were recorded at a seismic station in Elath, Israel, roughly equidistant from the two events. The short-period body waves generated by the two shocks were observed to have almost the same magnitude. The magnitude of the long-period Rayleigh waves recorded in these traces, in contrast, is clearly much greater for the earthquake than it is for the explosion. The ratio of long-period surface waves to short-period body waves has been shown to be a reliable criterion for distinguishing the seismic waves of earthquakes from those of explosions. In addition the *P* wave of the explosion has more high-frequency energy than the *P* wave of the earthquake. The *S* wave of the earthquake is large, whereas that of the explosion is small and not easily identified in the seismogram.



CLEAR DISTINCTION between earthquakes and explosions is evident in this plot of the magnitude of long-period surface waves (M_S) against that of short-period body waves (m_b). The 383 earthquakes represented by the black dots were compiled from a set of all the earthquakes recorded worldwide in a six-month period that had an m_b value of 4.5 or more and a focal depth of less than 30 kilometers. (There are fewer dots than earthquakes because the magnitudes of some of them coincided.) The colored squares designate underground explosions in the U.S. and the colored crosses underground explosions in the U.S.S.R. Only one earthquake falls within the explosion population, as defined by the straight line separating the two groups of events. This single event, which had the smallest magnitude of any of the earthquakes in the survey, took place in the southwest Pacific Ocean, a region where the sensitivity of the network of seismic stations is poorer than it is in most of the Northern Hemisphere. The m_b values were adjusted to take into account regional variations in the amplitudes of short-period waves.



METHODS OF DISTINGUISHING earthquakes from explosions were tested by applying the methods to all the earthquakes with a magnitude of 4.5 or more recorded during a 162-day period in 1972. The sample consisted of 948 events. Many of them could be classified as earthquakes (rather than explosions) by their location or their depth. The remaining events could be classified by comparing the magnitude of long-period surface waves with the magnitude of short-period body waves (the ratio $M_S : m_b$). The sequence in which the tests were applied affected the efficiency of the procedure, but all events were identified regardless of the sequence.

Another possible drawback of an exclusively external network should be mentioned. Confusion could arise when signals from two or more earthquakes reached a station simultaneously. The effect would be most troublesome when the long-period waves from a small event in the U.S.S.R. arrived at the same time as similar waves from a much larger earthquake elsewhere in the world. Under these circumstances it might be difficult to establish with certainty by comparing M_S with m_b the identity of the event in the U.S.S.R. With a network of 15 external stations there would be a few events per year in which the smaller earthquake was in the territory of the U.S.S.R. or within 25 kilometers of its borders and at a depth of less than 50 kilometers.

A monitoring network made up of 15 seismographic stations outside the U.S.S.R. and 15 inside it would largely eliminate the problem of coincident earthquake signals and would greatly reduce the maximum yield of an explosion that might escape detection, even if decoupling were attempted. The internal monitoring stations would be simple unattended ones, with the capability of measuring vertical ground motion and two orthogonal components of horizontal motion, so that the distance and direction of a nearby event could be estimated from the data of a single short-range station. With such a network in place, and assuming that muffling was attempted in the presence of normal earth noise, the largest explosion that would have a 30 percent chance of escaping detection in any setting except a salt dome would be .5 kiloton.

For salt domes the main area of concern in the U.S.S.R. is the region north of the Caspian Sea. Our hypothetical network has three stations there. Even a small explosion in a large salt-dome cavity would emit certain *P* and *S* waves with an amplitude large enough to be detected by nearby stations. Furthermore, detection by even one of the stations would immediately identify the event as an explosion because the area has no natural seismic activity. As a result evasion would not be likely to be attempted at a yield greater than one kiloton even in the salt-dome area.

A possible strategy for evasion that has been mentioned from time to time is the one of hiding the seismic signal of a nuclear explosion in the signal of a large earthquake, which might be near the site of the explosion or far from it. For the U.S.S.R. the only credible possibility is a distant earthquake because the only possible testing sites where earthquakes are frequent enough to make the effort worth while are on the Kamchatka Peninsula and in the Kurile Islands. Clandestine testing there is not likely because seismic activity in the area can be monitored in detail from stations in Japan and the Aleutian Islands. Indeed, ocean-bottom seismometers and hydroacoustic sensors could be placed just offshore.

The first defense against evasion by the masking of a test in a large earthquake is the questionable feasibility of the subterfuge. Unless the evader maintained several testing sites the number of opportunities per year for clandestine testing would be quite limited. In addition the evader would have to maintain his weapons in constant readiness for firing. To attain the evasion capability given below he would have to set off an explosion within 100 seconds of the time of arrival of the short-period waves of the earthquake. He would have to estimate the maximum amplitude and the decay rate of the earthquake waves with high accuracy, and he would have to be certain of the amplitude of the *P* waves generated by the explosion to within .1 magnitude unit. Even after taking these precautions the evader would have to accept a high probability that the event would be detected by at least one monitoring station and a small probability that three stations would detect it. He would also have to install and operate his testing site (including a large cavity) and his own seismological network in total secrecy over a period of years.

In contrast to these daunting requirements for successful evasion, the only requirements for a monitoring nation are to operate a network of high-quality seismic stations and to process the data with determination. Against a network of 15 external stations and 15 internal ones the only effective evasion schemes at yields of one kiloton or more would require both decoupling and hiding the explosion signal in an earthquake.

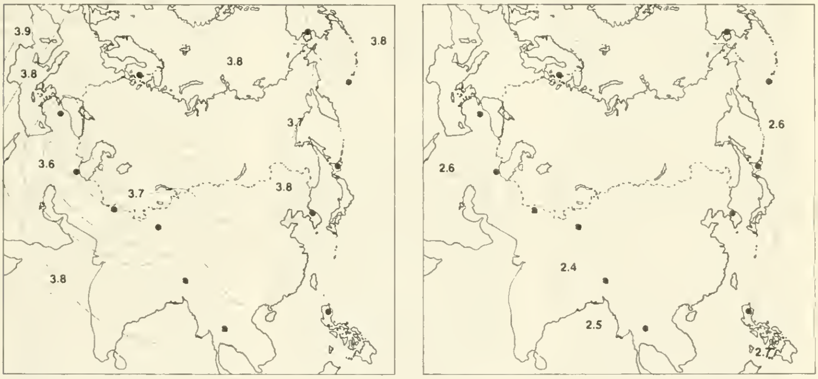
The issues relating to the monitoring of a comprehensive test ban can be summarized as follows. The understanding of seismology and the testing of seismometer networks are sufficiently complete to ensure that compliance with a treaty could be verified with a high level of confidence. The only explosions with a significant likelihood of escaping detection would be those of very small yield: less than one kiloton provided the monitoring system includes stations in the U.S.S.R.

It is important to view the question of yield in the context of the nuclear weapons that have been tested up to now. The ones that ushered in the nuclear age in 1945 had a yield of from 15 to 20 kilotons. Yields increased rapidly to the point where the U.S.S.R. tested a 58,000-kiloton weapon in 1961. The largest underground explosion had a yield of almost 5,000 kilotons. Unclassified reports place the yield of the weapons carried by intercontinental missiles in the range from 40 to 9,000 kilotons. The yields of underground explosions that might go undetected or unidentified under a comprehensive test ban are therefore much smaller than those of the first nuclear weapons. If the threshold of reliable detection and identification is one kiloton, that is only one-150th of the limit specified by the Threshold Test Ban Treaty of 1976.

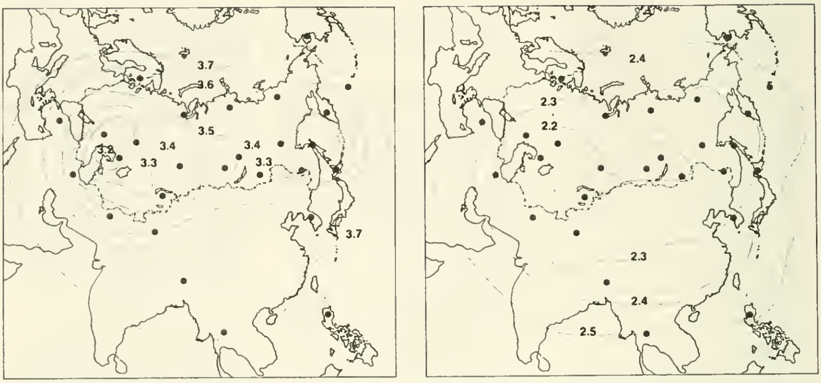
From the viewpoint of verification a comprehensive test ban would actually establish the equivalent of a very low threshold, since weapons of extremely low yield could be tested underground without the certainty of being detected and identified. A treaty that imposed a threshold near the limit of seismological monitoring capability might therefore be considered an alternative to a comprehensive test ban. Such a treaty might be preferable to the present quite high threshold, but it would have the disadvantage that arguments could arise over the exact yield of tests made near the threshold. Indeed, the judgment of whether or not a test has taken place will always be less equivocal than an exact determination of yield.

In recent years there have been reports that the U.S.S.R. may have repeatedly violated the 1976 treaty by testing devices with a yield greater than the 150-kiloton limit. Such reputed violations were recently cited as evidence that the threshold treaty, which has not been ratified by the U.S. Senate, is not verifiable and should be renegotiated. On the basis of our analysis we conclude that the reports are erroneous; they are based on a miscalibration of one of the curves that relates measured seismic magnitude to explosive yield. When the correct calibration is employed, it is apparent that none of the Russian weapons tests exceed 150 kilotons, although several come close to it.

Observations at the Nevada Test Site (NTS), where American nuclear-weapons tests are held, indicate there are lin-



THRESHOLDS OF DETECTION for seismic events in the Eastern Hemisphere are delineated by the two sets of contours drawn on this pair of maps for a proposed network of 15 seismic stations established outside the U.S.S.R. Colored dots give the location of 12 of the 15 stations; three others are off the maps. The number on each contour indicates that an event of that magnitude or larger has at least a 90 percent probability of being detected by four or more stations. The contours on the map at the left represent the detection thresholds for short-period body waves and those on the map at the right the detection thresholds for long-period surface waves. On these maps and the ones on the opposite page the only seismic noise taken into account is the microseismic noise generated by the atmosphere and oceans.



IMPROVED DETECTION THRESHOLDS for seismic events in the Eastern Hemisphere are delineated by the two sets of contours drawn on this pair of maps for a proposed network of 30 seismic stations: 15 outside the U.S.S.R. and 15 inside. For most of the U.S.S.R. the effect of adding the 15 interior stations would be to lower the detection threshold for short-period body waves from a magnitude of 3.8 to one of 3.4 (*left*); the corresponding effect for long-period surface waves would be to lower the detection threshold from a magnitude of 2.6 to one of 2.3 (*right*). The interior stations would also provide more accurate information on the focal depth of a seismic event.

ear correlations between the logarithm of the explosive yield and the two magnitude values, M_S and m_b, for explosions with yields greater than 100 kilotons. When the measured M_S and m_b values of explosions at the Russian test site near Semipalatinsk are inserted into the NTS formulas, however, the resulting estimates of yield given by m_b are more than four times as great as those given by M_S. For explosions in hard rock at many test sites estimates of yield based on the NTS M_S formula have invariably agreed with actual yields, whereas estimates based on the NTS m_b formula have sometimes been in drastic disagreement with the actual yield.

A strong correlation has been found between m_b values measured at individual stations and *P*-wave travel times to these stations. The U.S.S.R. routinely publishes seismological bulletins that include *P*-wave arrival times of earthquakes, and it is straightforward to interpret the times for stations in central Asia in terms of the expected pattern of m_b values near Semipalatinsk. From an analysis of the *P*-wave signals it is predicted that the m_b value for an explosion at Semipalatinsk is 40 percent greater than an equivalent explosion at NTS. This is the same correction that must be applied to the curve relating m_b to yield at NTS to make the m_b estimates of the yield of Russian explosions consistent with the M_S estimates. Thus two modes of analysis lead to the conclusion that there is an essentially universal relation between M_S and yield whereas the curve relating m_b to yield must be calibrated for each test site.

A comprehensive treaty would have an additional advantage over a low-threshold treaty: all technological uncertainties would work against the potential evader. A country planning a surreptitious nuclear test could not know the exact seismic-detection capability of other nations or the exact magnitude of the seismic waves that would be generated by his test. A ban on nuclear explosions of all sizes would also have the important conceptual value that nuclear weapons, no matter what their size, would be recognized as inherently different from conventional weapons.

It is sobering to consider how the state of the world would differ if a full test ban had been achieved in 1963. The number of nuclear weapons has grown tremendously since then and is now estimated at from 50,000 to 100,000. The loss of life and the social damage that would be inflicted in a major nuclear exchange are vastly greater than they were in 1963. Furthermore, both the U.S. and the U.S.S.R. are less secure now than ever before, not because of any failure to develop arms but because of the growing stockpiles of weapons and the inability of any nation to defend itself against nuclear attack.

A comprehensive test-ban agreement should not be regarded as a substitute for disarmament. Meaningful reductions in the nuclear threat must include a continuing and serious process of arms control; in this process, however, a comprehensive test-ban treaty could have an important part. The problems of negotiating such a treaty are overwhelmingly political rather than technical and must be recognized as such.

Before the suspension of negotiations between the U.S., Britain and the U.S.S.R. in 1980 tentative agreement had been reached on a number of issues. All three nations agreed that a test-ban treaty would include a prohibition of all tests of nuclear weapons in all environments, a moratorium on peaceful nuclear explosions until arrangements for undertaking them could be worked out, provisions for on-site inspections, a mechanism for the international exchange of seismic data and the installation of tamperproof seismic stations by each country in the territory of the others. The proposed treaty would have a term of three years. The agreements on the long-standing issues of on-site inspection, peaceful explosions and the placement of monitoring stations in each country represented important breakthroughs. It would be a setback for the cause of international security if this hard-won ground were now lost.

For many years the stated policy of the U.S. has emphasized the desirability of a complete test ban if verification could be ensured. The policy was not fundamentally altered by the recent decision of the Reagan Administration to put off further negotiations on the test ban. On the contrary, it was reported that the Administration still supports the ultimate goal of a comprehensive ban on nuclear testing but has doubts about the efficacy and reliability of seismic methods of verification. As we have attempted to show here, there can be no substance to such doubts.

The Authors

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APPENDIX 47

MARCH 1985 SCIENTIFIC AMERICAN ARTICLE ENTITLED "THE VERIFICATION OF COMPLIANCE WITH ARMS-CONTROL AGREEMENTS"

The Verification of Compliance with Arms-Control Agreements

Military activities in the U.S.S.R. can be unilaterally monitored by the U.S. with the aid of a wide spectrum of remote-sensing technologies, including high-resolution satellite photography

By David Hafemeister, Joseph J. Romm and Kosta Tsipis

The recent decision by the U.S. and the U.S.S.R. to resume bilateral arms-control negotiations was heralded by both governments with public statements emphasizing the need to halt and even reverse the growth of their nuclear arsenals and related weapon systems. Given the present climate of mistrust between the two nations, it is imperative that compliance with the terms of any treaty that might emerge from the new negotiations be unilaterally verifiable by each side. Verification requires that each nation have a reliable and objective means of monitoring the military activities of the other. Accordingly both nations have over the years developed a completely new family of systems for gathering such information from a distance. The systems are collectively referred to as national technical means of verification.

The issue of verification is quite separate not only from the legal question of whether an observed activity constitutes a treaty violation but also from the political question of what to do about a violation once it has been detected. Nevertheless, verification is more than just a technical issue. In the U.S., for instance, verification has been a focal point of the recurrent political debate over the merits of various existing and proposed arms-control treaties. Opponents of any particular treaty tend to argue that the U.S. cannot verify Soviet compliance well enough to maintain national security under the terms of the treaty, whereas advocates of the treaty tend to argue that the U.S. can.

In general the question of whether or not a treaty is verifiable by the U.S. can be reduced to two narrower questions. First, at what level of clandestine Soviet activity would U.S. security be jeopardized? Second, is the U.S. system of verification capable of detecting that level of activity?

What are the technologies needed to observe the development, testing, production and deployment of a weapon system? The earliest detectable signs of development might be communications between officials and scientists working on the weapon; some of these signals could be intercepted by monitoring radio waves. Alternatively, a spy might observe the weapon or its plans directly. According to a statement made in 1979 by William J. Perry, then Undersecretary of Defense for Research and Engineering, "we monitor the activity at the [Soviet missile] design bureaus well enough that we have been able to predict every ICBM [intercontinental ballistic missile] before it ever began its tests.... We have always in the past been able to detect an ICBM's existence before it ever went into tests."

Once a weapon arrives at the stage of testing outside the laboratory, the full spectrum of acoustic and electromagnetic energy can be exploited to gain information about it. Visible-light detectors such as those on photoreconnaissance satellites can "see" the weapon directly; infrared detectors on satellites can sense the heat emitted by a rocket exhaust plume during tests; radar can track a weapon in the air; sonar can track one in the water, and seismometers can detect and assess an underground nuclear test.

After a weapon has been fully tested it moves into production. Production involves large-scale transportation to and from manufacturing plants, an activity that can be monitored with the aid of visible light or infrared radiation. Finally, the operational deployment and training of personnel with the new weapon can also be monitored. The main difference in observing these processes is that in general testing and production must be detected while they are happening, whereas deployment involves activities that continue for years and can be detected at any time after they begin.

Determining whether the U.S.S.R. is violating the terms of a treaty, however, does not require observing everything having to do with the laborious process that culminates with the weapon's deployment. On the contrary, only parts of the activities involved, if they became known in sufficient detail, would be enough to identify their purpose and betray the violation of the agreement. This process of detection and identification is facilitated in a number of ways by the natural synergy among the various means of gathering information from inside the U.S.S.R. Information gathered by one monitoring system (say the electronic intercep-

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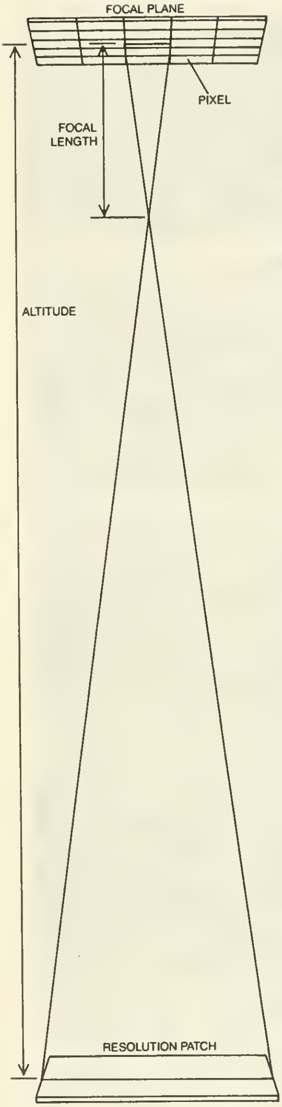
tion of messages) can tell another system (such as a photoreconnaissance satellite) where to look and what to look for. Furthermore, pieces of information gathered by one system, inconclusive by themselves, can reveal the nature of an ongoing activity when they are interpolated and correlated with other pieces gathered by other monitoring systems.

Putting the pieces of the puzzle together is as important as gathering them. There is, however, a measure of ambiguity and uncertainty inherent in this task. Some detected activities might not be observed in enough detail to establish that they represent violations of the provisions of some treaty. Other activities might be observed in great detail, but the relevant treaty provisions may be too ambiguous to determine whether or not those activities are violations. The efforts of the technical community have been devoted to reducing these uncertainties by developing surveillance technologies that produce highly detailed images and records of intercepted signals that are as free of noise as possible.

Ongoing activities and events that may produce visible permanent changes in the physical environment are most reliably detected by means of satellite photoreconnaissance, that is, the periodic photographing of scenes inside the U.S.S.R. by optical systems carried on a satellite in a comparatively low orbit. By photographing a scene repeatedly under the same conditions, one can see whether there have been changes in it. Given enough detail, it is possible to recognize the activity that caused the change. A special kind of camera collects light reflected by the scene and forms an image that is a pattern of light and dark (or colored) dots on a photosensitive recording surface. Each dot is called a pixel, or picture element. The size of the pixels, the focal length of the camera and the height of the satellite determine the system's resolution, which is the size of the smallest object on the ground that the system can distinguish [*see illustration on this page*]. The finer the detail available in a picture, the easier it is to detect changes from one picture to the next, and the smaller are the changes that can be detected. The increase in resolution enhances the information content of the pictures. Enhanced information content augments the probability that the activity responsible for the observed changes can also be identified.



GROUND RESOLUTION of a photoreconnaissance satellite is defined with reference to the idealized diagram at left. The diameter of a single resolution patch of the ground scene (designated r) is given by the formula $r = (h/f)d$, in which h is the height of the satellite, f is the focal length of the optical system and d is the diameter of a pixel, or picture element, in the recording medium. (All units are generally computed in centimeters.) The size of a pixel is determined either by the graininess of the photographic film or by the size of an individual cell in the charge-coupled device (CCD) used at the focal plane of the optical system to record the image. The resolution patch of the current generation of U.S. photoreconnaissance satellites is said to be roughly 10 centimeters.

Experience has shown that the presence of an object in a scene can be detected if the object is at least as big as the size of the resolution patch. If it is eight times bigger, it can be recognized (as, say, a tank or a truck), and if it is 12 times bigger, it can be identified (as, say, an older Soviet T-62 tank or a newer T-72). The size of the resolution patch of U.S. reconnaissance satellites is said to be smaller than 10 centimeters. Accordingly one can surmise that such systems can detect an object on the ground of approximately the same length, and that they can completely identify an object less than 1.5 meters across. The identification of objects and activities becomes even easier if pictures formed by reflected radiation of different wavelengths are available. By combining images of a scene made in infrared and ultraviolet radiation as well as visible light, an analyst can deduce additional information about an object or can detect camouflaged ones.

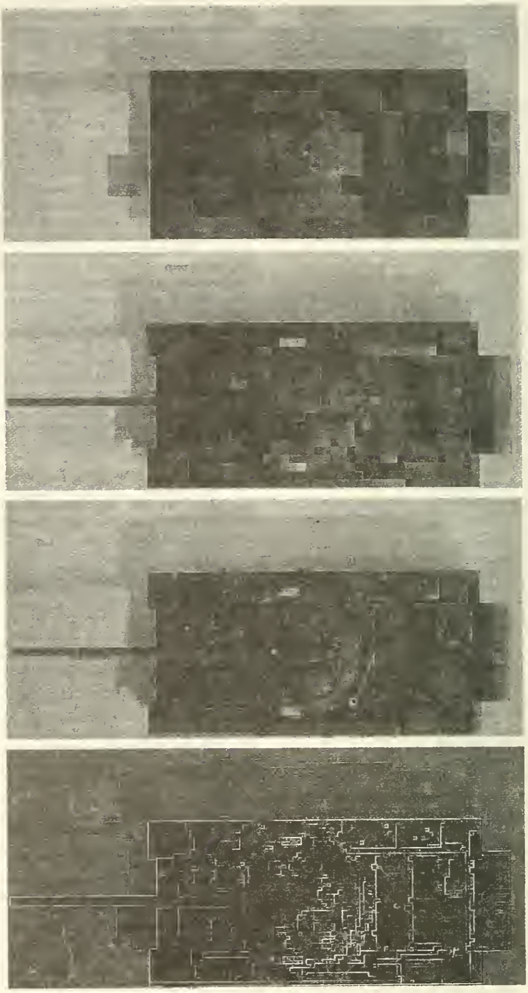
Once an image of the ground scene is formed by the camera, the image must be recorded and transmitted to ground-based facilities for analysis and interpretation. The recording can be done either on photographic film or on a two-dimensional array of photosensitive electro-optical detectors called charge-coupled devices, or CCD's. A detector of this type transforms the amount of light it receives in a short, fixed period of time into a proportional amount of electric charge. Thus the pattern of light creates an electrical replica of itself on the array of detectors. This pattern is converted in turn into a sequence of numbers, which is then transmitted to a receiver on the ground. Equipment in the ground station transforms the electrical replica of the light pattern recorded by the array into a picture. The process is then repeated and a new image is recorded.

In systems with a large focal length electro-optical arrays can achieve pixel sizes comparable with the best photographic film. In addition they offer a number of advantages over film. Images recorded on film can be transmitted in either of two ways. The film can be processed on board the satellite in a manner similar to the way a Polaroid camera develops its film; in that case the image is subsequently transmitted by a system similar to a television camera. Alternatively the film can be ejected from the satellite in special capsules, which reenter the atmosphere and, with the aid of a parachute, slowly descend until they are snared in midair by specially equipped aircraft. Both of these methods cause delays in the reception of the pictures and limit the useful life of the satellite, since the cameras eventually run out of film. The photosensitive arrays installed on U.S. satellites can, with the aid of a relay satellite, transmit images of the scenes they fly over in real time, as they are being observed. The pictures recreated on the ground have a much larger dynamic range than those obtained by means of photographic film; as a result they are not as sensitive to large changes in the intensity of illumination.

After the image of a scene has been received by a ground station it is possible to enhance its optical quality with the aid of fast computers and specialized processing devices. The technique is known as digital image processing. For example, the blurring of lines and shapes on a picture caused by turbulence, uncompensated motion, overexposure or poor contrast can be removed by artificially altering the gray areas of a picture and exaggerating the dark and light ones. The image processing enables one to identify characteristic patterns (such as the appearance of a missile silo observed from above) in pictures of the ground, or to complete a scene somewhat obscured by clouds.

The information-gathering capabilities of photoreconnaissance satellites are limited by the fact that a visible-light system cannot function at night, and by the fact that visible, ultraviolet and infrared radiation cannot penetrate through cloud cover. Thus bad weather and the polar night may prevent U.S. photoreconnaissance satellites from observing large parts of the U.S.S.R. for prolonged periods. This problem has been dealt with by turning to another part of the electromagnetic spectrum: radio waves.

Because the waves emitted by a radar system have a longer wavelength than visible light waves do, they remain largely unaffected by cloud cover and rain. Hence they can "illuminate" their target regardless of the weather. Since radars generate their own reflect-



EFFECT OF INCREASING RESOLUTION is simulated in this series of images of a plastic model of a Soviet tank. A photograph of the model was optically scanned to produce a digital record on magnetic tape. The information on the tape was then processed in such a way as to reproduce the image at three different pixel sizes, corresponding roughly to a resolution at which the object can be detected as a trucklike shape (*top*), a resolution at which the object can be recognized as a tank (*second from top*) and a resolution at which the tank can be identified as a Soviet T-62 (*second from bottom*). The enhanced image at the bottom was subjected to special processing steps to sharpen the edges and adjust the contrast.

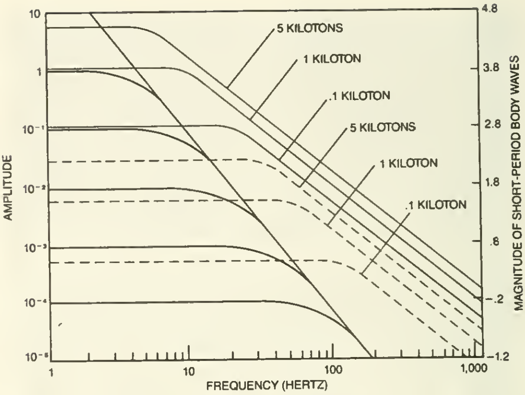
ed radiation, they can function at any time of day. The resolution of a radar system is proportional to the wavelength of the radiation it emits and inversely proportional to the length of its antenna; thus radar images of the ground normally have a very low resolution. The resolution can be increased by making the satellite's fairly small antenna appear to the reflected radar waves as if it were a very long antenna. This is accomplished with a method known as synthetic-aperture radar (SAR). A SAR satellite combines elaborate electronic processing of waves reflected by the target with the relative motion of the satellite with respect to the surface of the earth to achieve high-resolution radar images [see "Radar Images of the Earth from Space," by Charles Elachi; SCIENTIFIC AMERICAN, December, 1982]. The resolution of a SAR image is not as high as that of a comparable picture made with visible light; there is a practical limit to how large the "virtual" antenna can be made to appear to radio waves. It is good enough, however, to enable the U.S. to continue monitoring many activities in areas of the U.S.S.R. that are obscured by cloud cover or are in daylight for only a few hours a day.

Radars do not have to be satellite-based to provide useful information. Ground-, ship- and plane-based radars are the primary means by which the U.S. obtains information about Soviet missiles while they are being tested. This coverage is a good example of the synergy created by the variety of U.S. monitoring capabilities. The test firing of Soviet ballistic missiles, which takes place at the Plesetsk and Tyuratam missile-launching facilities in central Asia, is preceded by many activities. For example, early warning of a forthcoming test could come from a photoreconnaissance satellite that photographed the missile being prepared on its launch pad. The signal to turn on all sensors could come from intercepted communications or from the early-warning satellites in geosynchronous orbits above the Equator; such satellites "stare" at the U.S.S.R. and can detect the infrared radiation emitted by the fiery plume of a rocket exhaust as soon as the missile clears any cloud cover over the launching site. At that point the detection of radio waves becomes the primary means of gathering information.

Large, ground-based radars follow the motion of the missile as it goes through the various stages of its boost phase. Radar can measure continuously and with great precision the velocity of the missile and hence its acceleration by measuring the Doppler shift of the reflected wave. When the launching site of a missile is too deep inside Soviet territory to be observed by conventional ground-based radars, the U.S. utilizes "over the horizon" radars. These devices project beams that the ionosphere, acting like a mirror, reflects into the interior of the U.S.S.R. A radar of this type also provides useful information about the velocity of a missile.

Radio receivers both on the ground and on satellites in high orbit intercept the stream of messages the missile sends back to the ground during testing that describe the performance and conditions of the various parts of the missile. The messages, known collectively as telemetry, include information on how much fuel is being burned, what commands the guidance system is sending to the rocket, and what temperature and pressure different parts of the missile are experiencing. All these signals, which are needed by the missile's engineers to check whether it is functioning as designed, are also intercepted by U.S. monitoring facilities. By correlating such te-

RADAR IMAGE of a large eddy in the Gulf of Mexico reveals a ship's wake (*bottom*). Variations in surface roughness associated with the eddy and the wake were recorded by the synthetic-aperture radar on board the *Seasat* satellite. The processing of the image was done by workers at the Jet Propulsion Laboratory of the California Institute of Technology. The main advantage of satellite-borne radar systems for military surveillance is that they are able to function at any time of the day or night and in any kind of weather.



ABILITY TO DISCRIMINATE underground nuclear explosions from earthquakes now extends down to explosive yields on the order of one kiloton or even less, as shown in this graph, based on the work of Jack F. Evernden of the U.S. Geological Survey. The black curves represent earthquakes. The solid color curves correspond to nuclear explosions in soft rock and the broken color curves to "decoupled" nuclear explosions in mined cavities.

lemetry data with information about the motion of the missile gathered by ground-based radars, U.S. intelligence officers know not only that the U.S.S.R. has tested a missile but also what many of its performance characteristics are. Some telemetry signals from such tests have been encoded by the U.S.S.R. in order to make them incomprehensible to U.S. analysts, a practice that has been protested by the U.S. on the grounds that the unratified SALT II treaty stipulates the only signals that can be encrypted are those not directly relevant to the verification of the treaty [see "Science and the Citizen," February]. Even without access to unencrypted telemetry, however, the U.S. can detect the Soviet missile test itself with high confidence and can also determine such important performance characteristics of a ballistic missile as the number of reentry vehicles it is carrying.

The final phase of a ballistic-missile test is the return of its reentry vehicles to the atmosphere and their impact on the ground. Since atmospheric forces affect the flight paths of the reentry vehicles, information about their performance in this terminal phase provides an important measure of the missile's accuracy and is crucial for the U.S.S.R. to have. Consequently, during Soviet missile tests, the reentry vehicles are aimed at instrumented impact areas either on the Kamchatka Peninsula or in the central Pacific Ocean. The U.S. has developed a range of sensing systems that monitor the return of the Soviet reentry vehicles to these areas. Very precise phased-array radars (which can detect an object the size of a basketball from thousands of kilometers away and can simultaneously track hundreds of such objects), radio receivers, infrared and visible-light telescopes equipped with cameras and rapid-scan spectrometers record in great detail the various forms of radiant energy emitted and reflected by the reentry vehicle. Some of these instruments are based on Shemya Island at the tip of the Aleutian Islands chain and at Kwajalein atoll in the Pacific; others are carried by ships and planes and even by small sounding rockets launched in anticipation of the arrival of the reentry vehicle.

From all these data, correlated and interpreted by intelligence analysts, the U.S. can estimate with great confidence many of the characteristics of the tested Soviet weapon. (For example, how big is its booster? How long is its range? How heavy are the reentry vehicles?) Other characteristics are much more difficult to determine with confidence. Accuracy, for instance, can only be determined statistically from the flight path and impact point of the reentry vehicles. If the U.S. does not know at exactly what point the Soviets were aiming their reentry vehicles, then considerable uncertainty is introduced into the U.S. estimation of their accuracy. Determining the reliability of Soviet ICBM's and reentry vehicles is also statistically uncertain. Some characteristics are extremely difficult to establish. The potential yield of the weapon that will be placed on the reentry vehicle can be only crudely approximated from the vehicle's weight. Nevertheless, the unilateral technical means of monitoring the testing of Soviet ballistic missiles available to the U.S. can be relied on with confidence not only to detect such tests but also to provide the U.S. with a great deal of information about the performance of the tested weapon.

The nuclear warheads that missiles carry must be developed by means of underground testing. This state of affairs is the consequence of the Limited Test Ban Treaty, signed by the U.S., the U.K. and the U.S.S.R. in 1963, which banned such tests in the atmosphere. The detection technology needed to monitor underground tests consists of seismometers that detect the acoustic waves generated by an explosion, recording equipment and computers that analyze the data. Atmospheric testing, if resumed, would be easily monitored by special satellites and by an array of other techniques, including many discussed above.

Underground explosions generate elastic waves that propagate both on the surface and through the crust of the earth over very long distances. The magnitude and point of origin of such waves can be determined with the help of sensitive seismometer arrays. The seismometers are permanently "on," and so they detect and record all earth tremors, including those caused by an explosion.

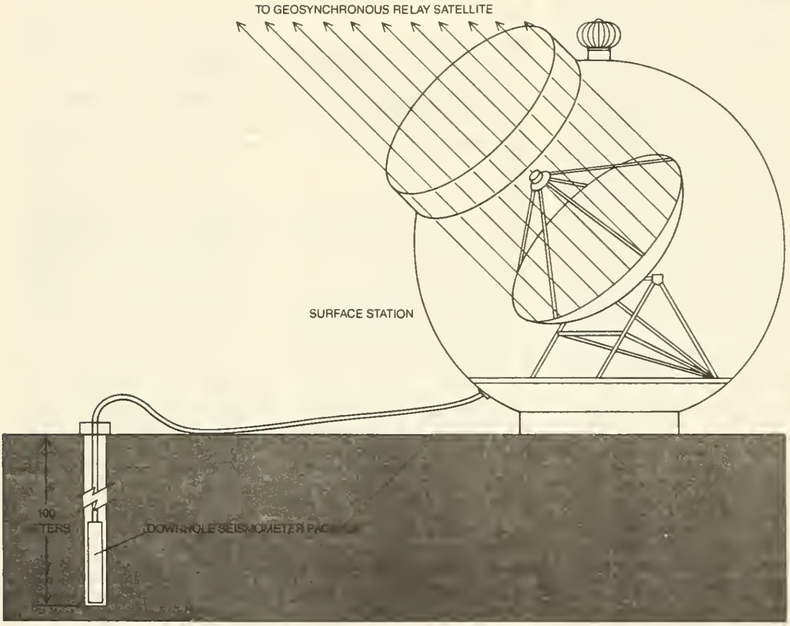
A persistent problem in the seismic detection of underground nuclear test explosions has been the fact that such explosions yield elastic waves roughly similar to those of many other events, such as naturally occurring earthquakes; the waves are recorded the same way by the arrays of seismometers. Thus the risk existed that a nuclear explosion could be mistaken for an earthquake, and vice versa. Subsequent research effectively eliminated this difficulty for all but the smallest nuclear explosions [see "The Verification of a Comprehensive Nuclear Test Ban," by Lynn R. Sykes and Jack F. Evernden; Scientific American, October, 1982]. Yet two conceivable sources of evasion remained. The U.S.S.R. might arrange to test a small nuclear explosive during an earthquake. The seismic waves from the earthquake might obscure the signal generated by the detonation. It also seemed possible for a time that the energy from a low-yield device could be effectively muffled by detonating the weapon in a large underground cavity, making the blast undetectable outside the U.S.S.R. It has recently been reported, however, that a team of geophysicists at the U.S. Geological Survey's office in Menlo Park, Calif., has developed a means of unambiguously detecting a nuclear explosion as small as one kiloton or even smaller, given improved monitoring equipment.

The new detection technique takes advantage of the fact that an earthquake is a widespread event; as a consequence the acoustic energy it emits is concentrated at long wavelengths. A nuclear explosion, on the other hand, is a pointlike event that releases a huge amount of energy abruptly into the environment. Both the limited extent and the suddenness of such an event force it to release its energy in much shorter waves, which have higher frequencies. As a result the waves from a nuclear explosion can be detected and recognized by their frequency characteristics even if they are accompanied by those of an earthquake.

For example, waves from an earthquake can obscure the signal from a one-kiloton decoupled explosion up to frequencies of 10 hertz or so [*see illustration on preceding page*]. The earthquake waves, however, contain no detectable energy in frequencies above about 30 hertz, whereas waves from an explosion contain detectable energy up to frequencies of several hundred hertz. Thus seismometers tuned to detect only high-frequency waves will not "hear" the earthquakes; the seismometers will not be confused by the constant noise of the earth but will easily detect the explosion-generated waves.

Because high-frequency acoustic waves do not travel very far through the earth's crust, their detection would require placing seismometers inside the U.S.S.R. This potentially delicate political problem has been solved by the development of an unmanned seismic station. Workers at the Sandia National Laboratories have devised, tested and are now operating five unmanned seismic stations in the U.S. and Canada for practice and for demonstration purposes [*see illustration below*]. The stations communicate constantly by satellite relay with a central control facility in the U.S., making them virtually tamperproof. The U.S.S.R. accepted a proposal for the emplacement of such stations on its soil during negotiations for a comprehensive test-ban treaty, which were interrupted by the U.S. in 1980 after the Soviet invasion of Afghanistan. Consequently there appears to be no technical obstacle to monitoring with great confidence underground nuclear tests releasing as little as one kiloton or less of energy.

The three types of national technical means of monitoring Soviet activities discussed above—those that create



UNMANNED SEISMIC STATION developed by workers at the Sandia National Laboratories could be helpful in verifying compliance with a comprehensive nuclear-test-ban treaty. A system of five such stations is currently being operated in the U.S. and Canada.

images, those that detect electromagnetic waves emitted or reflected by missiles during tests and those that listen for acoustic waves—exemplify the sophistication of U.S. monitoring capabilities. Indeed, the level of detail the U.S. is able to detect suggests the kinds of treaty provision the U.S. can and cannot verify. The point is significant: the guiding principle for agreeing to any treaty provision must be that the U.S. is able to have confidence it can detect violations that could threaten its national security. Whether the U.S. can detect such violations depends both on what it considers threatening to its national security and on the physical properties of the weapon system or the military activity limited by the treaty.

For example, given unmanned U.S. seismic stations inside the U.S.S.R., what kind of treaty provisions limiting underground nuclear tests can U.S. seismic detectors verify compliance with? We have already shown that with such stations the U.S. can detect underground nuclear tests with an energy yield as small as a kiloton. Does this capability enable the U.S. to enter a treaty banning all underground nuclear tests confident that any Soviet violations that could harm U.S. security would be detected? The U.S.S.R. could attempt to test significantly below the U.S. detection level, conducting a clandestine test of, say, 100 tons. The Soviets have already conducted hundreds of much larger tests, however; what is more, a 100-ton test would be 1,000 times smaller than their smallest strategic nuclear weapon and 250,000 times smaller than their largest. They would not be likely to derive any useful information from such a low-level test, even if it were a test of a new type of weapon. Therefore it is improbable that a test significantly below the U.S. detection level of one kiloton could threaten U.S. security. Conversely, any test that might give them useful information would certainly be detected. Hence the comparison between what the U.S. must confidently detect and what the U.S. can confidently detect in the case of underground nuclear tests leads to the conclusion that the U.S. could verify a comprehensive test ban well enough to maintain national security.

Similar assessments can be made with regard to the ability of the U.S. to monitor Soviet missile tests. For example, is this ability adequate to monitor an agreement limiting improvements in accuracy in ICBM's? Unilaterally determining missile accuracy by observing ballistic-missile tests is statistically uncertain at best, and so accuracy improvements achieved in defiance of a limitation would be difficult to monitor. On the other hand, if the U.S. decides it is important to constrain Soviet accuracy, there is another option: banning all ballistic-missile tests. Verifying that a ballistic-missile test has taken place can be done with high confidence. Indeed, the probability that the U.S. would detect a single Soviet flight test is certainly higher than 90 percent, given the variety of means the U.S. has to detect these tests. At least 20 test flights are required to determine with confidence the accuracy of a new missile. Therefore, even if the U.S. can be confident that it can detect the test of a Soviet ballistic missile only 90 percent of the time, its chances of not detecting one of 20 Soviet tests is only one in 100 billion billion (10^{20}). In short, a treaty banning ballistic-missile testing altogether could be confidently verified. In addition, since the U.S. can determine the number of reentry vehicles a ballistic missile is capable of delivering, another verifiable treaty would be one that would restrict flight testing to missiles designed to carry a single warhead.

When it comes to monitoring the production and deployment of Soviet strategic weapons there is little doubt that U.S. photoreconnaissance satellites can confidently detect and count such large strategic-weapon delivery systems as ICBM's, submarine-launched ballistic missiles (SLBM's), submarines and bombers. The key question is: With what accuracy must such weapon systems be monitored in order to ensure against erosion of U.S. national security by violations of treaties limiting or forbidding their production or deployment?

Keeping activities that violate a treaty banning an entire weapon system secret is particularly difficult. The large-scale activities involved in developing, testing, producing and deploying significant numbers of any large weapon are easily observed. Indeed, any effort to conceal such activities would be handicapped by the fact that the Soviets do not know exactly what the U.S. can detect. Therefore they do not know what to attempt to hide, and they do not know with what thoroughness they must try to conceal the details of visible changes that the proscribed production of a weapon would cause.

Confidence in verifying numerical limits on a weapon system would depend on the number of weapons permitted. In general it is hard to have confidence in the verification of agreements that involve small numbers of weapons. A complete ban of a missile system would be easier to verify than an agreement that allows, say, 100 such missiles on each side. If the Soviets were supposed to have none, as soon as the U.S. monitoring systems detected one it would become apparent that the Soviets had violated the agreement. If the agreement were to allow 100, however, it would be quite difficult to know whether they had 100 or 120. Arms-control agreements that completely forbid a weapon system, a practice or an activity are much easier to monitor and verify for compliance than agreements that allow small numbers of weapons.

The U.S.S.R., however, has dozens of submarines and bombers, some 1,000 SLBM's and about 1,400 ICBM's. The U.S. is often said to be able to verify these numbers to within 10 percent or better (a credible claim in the light of the previous discussion of U.S. verification capabilities). This estimate implies that the U.S. can verify compliance with numerical limits accurate to the order of a few submarines and bombers and perhaps 100 SLBM's or ICBM's. Given the large numbers of weapons both nations now have, such verification accuracy seems more than adequate to maintain U.S. security under a treaty that limited the production of strategic weapons.

One special case is the problem presented by cruise missiles: small pilotless drones several meters long. The main complicating factor here is that the same type of cruise missile can be fitted to carry either a nuclear warhead or a conventional one. Hence differentiating cruise missiles carrying nuclear warheads from those carrying conventional warheads is an extremely difficult task. It is likely that any verifiable treaty dealing with cruise missiles must cover the total number of cruise missiles allowed, without distinguishing between nuclear and conventional warheads.

We have discussed a variety of powerful remote-sensing technologies but only some of their verification applications. (For instance, we have not described how these technologies could serve to verify a treaty dealing with antisatellite weapons.) Moreover, the actual intelligence capabilities of the U.S. are much greater than we have described here. Not only are there too many verification technologies to discuss in such an article, but also (and more significant) the nature of the intelligence-gathering process is such that many of the methods and sources by which the U.S. gains knowledge of Soviet actions are classified. Even our necessarily limited discussion, however, suggests that the rich remote-sensing capability of the U.S. can adequately verify a wide range of treaties.

APPENDIX 48

JANUARY 18, 1985 SCIENCE ARTICLE ENTITLED "SEISMIC VERIFICATION OF A COMPREHENSIVE TEST BAN"

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Seismic Verification of a Comprehensive Test Ban

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A Comprehensive Test Ban Treaty (CTBT) prohibiting all testing of nuclear weapons has been discussed for more than 20 years. In 1977 the United States, the Soviet Union, and the United Kingdom reentered formal CTBT negotiations. Although these negotiations have been in recess since 1980, public interest in such a test ban is widespread.

Summary. "The capabilities of in-country seismic monitoring systems for verifying the absence of underground nuclear explosions are compared against challenges posed by possible clandestine testing schemes. Although analyses indicate that extensive networks of in-country seismic arrays are needed to verify a Comprehensive Test Ban Treaty, such networks cannot ensure that all underground nuclear explosions will be identified." Political and military judgments will determine the level of risk acceptable to each nation.

Adequate verification measures are central to both formal and informal CTBT discussions. Because the Limited Test Ban Treaty of 1963 prohibits testing in the atmosphere, oceans, and space, verification concerns introduced by a CTBT focus on testing underground. However, a CTBT may change the relative importance of verification issues under other treaties.

This article discusses the goals of verification for a test ban treaty and evaluates networks of seismic stations with characteristics similar to those proposed for a CTBT verification system (*1*). The performance of these networks is compared with the challenges posed by credible clandestine testing schemes.

Goals and Costs

In general, three goals of adequate verification systems can be identified: (i) to deter militarily significant testing programs (*2*); (ii) to ensure that significant attempts to continue underground testing and evade detection are identified in time to respond appropriately (*3*); and (iii) to build confidence by minimizing the number of natural or man-made nonnuclear events that are misidentified as nuclear explosions or remain unidentified.

By definition, a CTBT prohibits all testing; however, the limitations of realistic monitoring systems prevent 100 percent verification of compliance. Therefore, realistic performance measures must be established. Political, military, and weapons design considerations will help define such performance measures (*4*) by balancing judgments about the relative importance of each goal with estimates of the technical capabilities of the monitoring systems, definitions of what constitute militarily significant testing programs, and broad national policy issues (for example, linkage to compliance in other arms control areas). If deterrence is emphasized, the perception of the verification system and cost-versus-benefit evaluation of clandestine tests by the nation considering them must be estimated by other nations. If assurance that a treaty violation will be identified is emphasized, political responses to incomplete evidence of clandestine testing are important.

In some cases, measures to meet one goal are sufficient to meet another; for example, requirements to ensure that clandestine testing or treaty evasion attempts will be identified are, themselves, significant deterrents. However, a balance must be struck. If the requirements for showing that a treaty violation has occurred include a low detection threshold, many small earthquakes and nonnuclear explosions will be detected but not identified, and this could decrease confidence that the treaty is being honored.

In discussions on adequate verification some hold the position that any testing by the other side significantly threatens national security (*2*, *4*). Further, some speculate that the probability of evasion attempts, given the right circumstances, is high irrespective of potential political costs. Proponents of these views suggest that the probability of identifying a single clandestine test should approach 90 percent. Others argue that only repeated testing has military significance (*5*) and suggest that the costs of being caught are so high that even a small possibility of detection would be a deterrent. Proponents of this position suggest that our verification provisions need only a 30 percent probability of detecting a single test. In effect, they equate a high (but unspecified) degree of confidence in deterrence capability with a low probability of detecting a single violation. The two approaches can be compared quantitatively: given a 30 percent probability of detecting a single event, seven tests would have to be conducted before the probability of identifying at least one violation in the series exceeds 90 percent.

The costs of negotiating, deploying, and operating verification systems also help determine their specifications. Considerations include money and manpower and such intangibles as the presence of foreign personnel near sensitive loca-

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tions, technology transfer, efforts to resolve false alarms in one's own and other countries, and concessions to negotiate verification provisions not desired by other treaty participants. Ultimately, each nation evaluates these costs in light of its security goals.

Verification Systems

Verification systems include components that are under differing degrees of national control. Some, called national technical means (NTM), are controlled by the monitoring nation—satellites and seismic stations operated outside the monitored country are examples. Others are negotiated as part of the treaty and involve interactions between treaty participants; for example, provisions for in-country local seismic networks and hydrodynamic measurements of yield are part of the Peaceful Nuclear Explosion Treaty. Finally, the openness of the society and the availability of information are factors.

Significant differences exist between NTM and negotiated elements. Although the NTM's precise properties are known by only one side or party to a treaty, many properties of and data from the negotiated provisions are known by both sides. The only aspects of the negotiated provisions that will not be known by all parties are the processing to be applied to the data and the decision-making steps that follow. Even these aspects can be partially determined through repeated exchanges about possible treaty violations, allowing potential evaders to calibrate the overall system.

Another difference is that countries may be unwilling to present evidence from NTM in international forums even though it indicates that a violation has occurred. Such decisions are made to protect some NTM capability for future use or because the credibility of the NTM has not been established internationally. Generally, neither consideration constrains negotiated provisions.

Verifying CTBT compliance requires both NTM and negotiated elements. NTM could include external seismic stations and satellites. Negotiated elements could include networks of seismic stations within the countries to be monitored, providing data to all treaty participants (*1*), and "voluntary" on-site inspection privileges to resolve ambiguous events (*4*).

In-Country Networks

There are significant differences between data recorded by external and in-country seismic stations. External stations, distant from potential test sites, record the motion of only a few useful waves (for example, compressional and surface waves) from larger events—that is with seismic magnitudes (m_b) greater than ~4. Frequencies greater than ~5 hertz in the data have generally been reduced by attenuation and scattering within the earth. In-country stations, being closer to the sources, record multiple useful waves with large amplitudes, broad spectra ($0.02 < f < 10$ hertz) (*6*), and, in some cases, even higher frequencies from both large and small events (Fig. 1) (*6a*).

These differences give in-country stations advantages for detecting seismic waves and identifying their sources. The large amplitudes increase the probability of detection. The multiple phases observed by in-country stations leave the source at different angles and provide more samples of the source radiation pattern. The broad spectra and high-frequency content increase opportunities for using spectral differences to distinguish between explosions and earthquakes (*7*). The proximity of source and receiver (<800 kilometers) helps locate the source more accurately.

To use these advantages, data acquisition equipment must have a large dynamic range and good resolution over a broad range of frequencies. Triaxial seismometers or small seismic arrays are needed to determine the direction from which the waves approach.

The data must be transmitted and checked to ensure faithful recording. Then they must be processed and analyzed in three interdependent steps: (i) initial data processing, including seismic signal detection, association with a common source, measurement of properties, and wave identification (compressional, shear, and so on); (ii) characterization of source properties, including origin time, epicenter, and azimuthal variation in the energy radiation pattern as a function of time and frequency; and (iii) identification and discrimination among sources (for example, nuclear versus chemical explosions or earthquakes) for events in regions of interest.

Well-defined signals from a few stations are used to determine a trial location and origin time. If a structural model has been determined from initial in-country studies, the arrival times and amplitudes of waves arriving at other stations are predicted and the seismic data at all stations reexamined for additional signals. Then the trial location is redetermined and the process repeated. The final location forms the basis for an initial decision about the signal source, the focusing of other NTM, and more intensive efforts to identify the source.

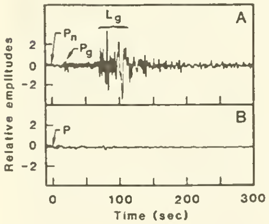


Fig. 1. First 300 seconds of vertical-component traces from two comparable earthquakes recorded on the same instrument. (A) "Regional" magnitude 5.6 event, 480 km from the station. (B) "Teleseismic" magnitude 6.4 event at 2990 km. The regional signal has larger amplitudes, more high-frequency information, and multiple identifiable phases to help detect, characterize, and identify the source. P_n and P_g are compressional waves that propagate in the upper mantle and crust, respectively. L_g is a complex wave composed of higher mode surface waves propagating in the crust. P_g and L_g are strongly dependent on the crustal structure and propagate to limited distances.

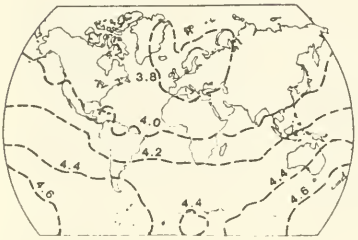
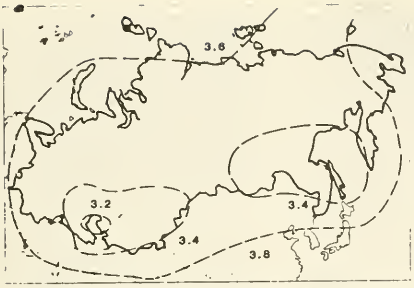


Fig. 2. Estimated short-period detection capability for hypothetical network of 50 stations distributed worldwide (*9*). The network represents existing stations, including five in the Soviet Union. Contours represent the m_b of the seismic event estimated to be detected with 90 percent confidence by a network of four or more stations.



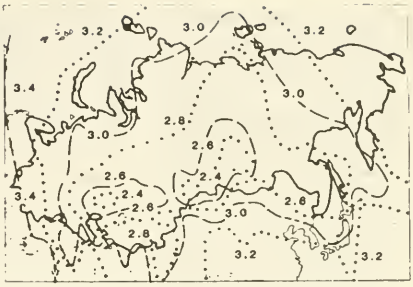


Fig. 3 (left). Estimated short-period detection capability at 90 percent confidence level for a network of 30 stations, including 15 within the Soviet Union (*5, 10*). Fig. 4 (right). Estimated short-period detection capability at 90 percent confidence level for a network with stations at the same sites as in Fig. 3 but with small arrays instead of single instruments at internal stations.

The information needed by the United States for these functions will be based on empirical and theoretical knowledge from studies of U.S. explosions and earthquakes and initial experience with in-country systems in the Soviet Union. Information about waveforms recorded at in-country stations from Soviet nuclear weapons tests or nuclear and chemical explosions in their civil applications program (*8*) is limited. This lack of in-country Soviet explosion data seriously limits U.S. confidence in its ability to identify small seismic events. The Soviets labor under no such limitation. U.S. seismic data and nuclear test information, including many explosion yields, are widely available.

Network Capabilities

At a given location, the detection capability of a seismic network is defined as the seismic magnitude of the source that will be detected there with a specified degree of confidence. Detection capability is estimated from the probability that the signal from a source at the given location will be sufficiently greater than the noise at a receiver site to be noticed by an analyst. Individual probabilities for distant stations, which contribute only a single short-period signal to the detection process, are combined to determine the probability that four or more stations will detect the event. (Four independent measurements are needed to determine the three spatial coordinates and the origin time of the source.) Figure 2 shows the calculational results for a hypothetical network of 50 stations distributed worldwide, including five in the Soviet Union (*9*).

Although nations could attempt clandestine testing outside their borders, and nuclear proliferation is a concern, the focus in this article is on monitoring within the Soviet Union. The size of the Soviet Union (almost 2.5 times larger than the contiguous United States) and operational and security considerations provide many possible sites for clandestine testing. Evernden (*10–12*) and Sykes and Evernden (*5*) describe a 30-station network for monitoring the Soviet Union. It includes 15 high-quality stations surrounding the Soviet Union and 15 simple stations, each with a single triaxial seismometer, within the Soviet Union. Figure 3 illustrates their estimates of this system's detection capabilities. Although their estimates do not make full use of regional phases to enhance detection capability, they predict significantly better capability than shown in Fig. 2.

Figure 4 indicates the detection capability predicted for the Sykes and Evernden network with 15 simple in-country stations replaced by small-aperture regional arrays. The improvements result from explicit use of multiple seismic waves and array stations in extensions of calculational procedures described by Evernden (*11*). The array stations were assumed to have an effective noise level 12 decibels lower than the simple stations and improved abilities to detect and use combinations of regional seismic waves (for example, P_n, P_g, and L_g in Fig. 1). These improvements may help locate seismic sources from signals detected at as few as two stations.

The network would be expected to have a 90 percent probability of detecting seismic events with magnitudes greater than 3.0 or 3.1 in about 90 percent of the Soviet Union (Fig. 4). This contrasts with detection capabilities of 3.8 to 3.9 for the network with distant stations only (*9*) and 3.4 to 3.5 for the Sykes and Evernden network (*5, 11*). The capabilities of networks with in-country arrays are as low as 2.4 in specific regions, but, because the properties of internal stations are known, these localized high capabilities may not represent conditions that are present when a clandestine test is attempted. Also, the networks include external stations of unknown political viability in Iran and Afghanistan.

Figure 5 indicates the dependence of detection capability estimates on the number of internal stations and contrasts the capabilities of simple stations with stations that are small-aperture regional arrays. These estimates involve assumptions about the regional properties of signals and noise in the Soviet Union because of the lack of information about seismic wave properties there.

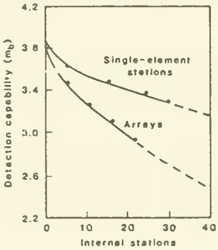
Figure 6 shows the estimated effects of varying some parameters. Changes in the signal-to-noise ratio (SNR) and required confidence levels have significant effects. If the SNR at internal stations decreases 12 decibels, detection capability is degraded 0.4 magnitude units. Relaxing the degree of confidence from 90 to 30 percent produces an apparent increase in the network's detection capability of 0.25 magnitude units.

The sensitivity of the estimated capability to variations in SNR is particularly important because noise levels and wave-propagation properties in the Soviet Union are poorly known to the United States while the Soviets will know these properties and the real-time data from internal stations. Thus, explosion sites could be selected such that the paths attenuate signals to stations providing the greatest constraint on evasion, or explosions could be detonated during high noise, or both.

Characterization and Identification

If waves from an event have been detected, the source must be characterized and identified as a nuclear explosion, an earthquake, or a chemical explosion. This process has several elements. First, event depth is an initial discriminant since current drilling limits are less than approximately 15 kilometers. Therefore, we can eliminate from consideration with confidence events deeper than 25 kilometers.

Second, earthquakes of magnitude 4.5 and above occur in fairly well-defined areas in the Soviet Union (Fig. 7) (*13*). Events with magnitudes greater than 4 occurring outside these areas would be presumed explosions, and detection of such events is nearly equivalent to identification. Similar statements cannot be made for smaller magnitudes. For example, we recently supported a study of parts of Louisiana, Oklahoma, and Texas where only one earthquake with a magnitude greater than 4.5 occurred in 8 years. The study revealed almost one earthquake per day in the magnitude range of 2.0 to 3.9 (*14*). These results and the low-level seismicity observed in many areas with granite outcrops indicate that identification of small events will be a distinct operation throughout much of the Soviet Union.



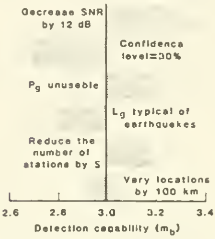


Fig. 5 (left). Overall detection capability as a function of number and type of internal stations. Above this magnitude, explosions at any point in 90 percent of the Soviet Union would be detected with 90 percent confidence. In specific areas, capability is up to 0.6 magnitude units better than overall network capability (see Figs. 2 to 4). Fig. 6 (right). Sensitivity of overall detection capability to variations in assumptions made in calculating network capability in Fig. 4. Calculations were carried out for a 90 percent degree of confidence.

One discriminant for large events that are not eliminated by depth or location is that surface-wave magnitudes for earthquakes are generally larger than those for explosions with the same body-wave magnitudes (*15, 16*). Although evidence is incomplete and contradictory, this separation may exist at low magnitudes in some regions (Fig. 8) (*17–19*).

Other promising discriminants based on variations in spectral content and radiation pattern (*7*) have received limited study for low-magnitude events. However, regional signal variations will cause the discriminants' effectiveness to vary significantly.

Characterization and identification typically involve spectral analyses and examination of seismic-wave particle motion, requiring a greater SNR than that for detection. Presumably most events of 0.5 magnitude units greater than the detection level will be characterized and identified (*11*).

The efficiencies of characterization and identification algorithms in this 0.5-magnitude-unit interval are not known for internal stations. We assume the algorithms are relatively efficient so that only 20 percent of the events in this interval will remain unidentified. Because small but potentially significant events (magnitudes 2 to 3) are poorly reported, their numbers must be estimated from larger events (Fig. 9) (*20*). Figure 9 shows estimates indicating that 100 to 1500 events per year may remain unidentified at magnitudes of 2 to 3. These magnitudes correspond to cavity-fired explosions with yields of a few kilotons (that is, equivalent to a few thousand tons of chemical explosives), and the events pose a significant problem to treaty verification. These estimates do not include contributions from earthquake swarms or aftershock sequences. These can contribute significant numbers of (often similar) events in limited time periods.

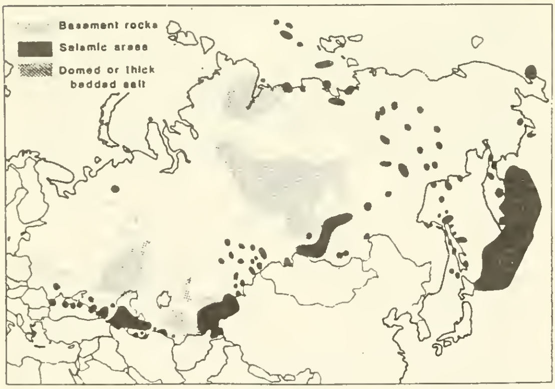


Fig. 7. Regions in the Soviet Union where earthquakes larger than magnitude 4.5 occurred between 1911 and 1967 (*13*) and regions of salt deposits and rock suitable for cavity decoupling (*27*). The distribution of smaller earthquakes is not known, but earthquakes in the range 2 to 2.5 are thought to be widespread (*14*).

Constraints on Evasion

Successful evasion of the verification process can occur if any step in the process is prevented. Evasion is unnecessary if detected signals are attributed to natural seismic events or chemical explosions. Here, the focus is on evasion techniques that affect the detection of a nuclear explosion.

The probability of detection may be decreased by reducing the explosive energy that is transmitted (or coupled) into the earth at the source or by choosing source-to-receiver paths that absorb significant seismic energy. Clandestine testing schemes that rely on decoupling appear to determine the numbers and types of in-country stations that are required for adequate verification. Schemes that rely on raising background noise, such as hiding explosion signals in earthquake coda or in natural or man-made noise, are also important but place less stringent constraints on the monitoring network.

To interpret network detection capabilities in terms of yield, the relations between magnitude and yield from the Nevada Test Site (NTS) are used (Fig. 10). Their applicability to the Soviet Union is under study. Various investigators (*21–23*) have shown that certain explosions at the main Soviet test site register several tenths of a magnitude unit higher than the same explosions at NTS, thus demonstrating a bias between the sites. The relation between magnitude and yield at low yields is uncertain.

The top band in Fig. 10 illustrates seismic magnitudes generated by explosions well coupled to hard rock in a region like NTS (*24, 25*). A well-coupled 1-kiloton (kt) explosion at the Soviet test site will have an average m_b of 3.8 to 4.2, depending on the NTS-Soviet bias.

Smaller m_b values can be generated for given yields by exploiting systematic reductions in the interaction between the explosion and surrounding material. The middle band in Fig. 10 shows the magnitude to yield relation expected for explosions detonated deep in dry alluvium like that in some NTS areas (*25*). Such material muffles explosions, and the depth prevents collapse craters common with shallow events.

Limited U.S. knowledge of Soviet geology indicates such material is rare in the Soviet Union. If it exists, 1-kt devices fired in it would have seismic magnitudes of 2.8 to 3.4, depending on the NTS-Soviet bias. Such events could remain undetected at the 90 percent confidence level by networks with 15 internal array stations (Fig. 4). Because characterization and identification capabilities require higher SNR's, the probability that networks would identify such explosions is significantly lower.

If cavities with explosion-produced wall stress below the elastic limit were constructed, further decoupling gains would be achieved. The lowest band in Fig. 10 shows the magnitude range predicted for explosions detonated in such cavities (*26*). If the variation in NTS-Soviet bias is combined with the spread in the decoupling factor and the magnitude-yield curves at low yields are known, cavity-detonated explosions with 1-kt yields would have seismic magnitudes in the range of 2.2 to 2.7. To approach the capability of detecting magnitude 2.6 events with 90 percent confidence in 90 percent of the Soviet Union, networks would need approximately 30 internal arrays (Fig. 5). Because the signals from decoupled explosions are small, the seismicity cannot be considered localized. Thus, additional array stations would be needed to achieve the same degree of confidence in characterization and identification. The negotiability of such networks is uncertain.

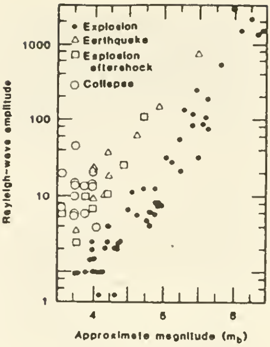
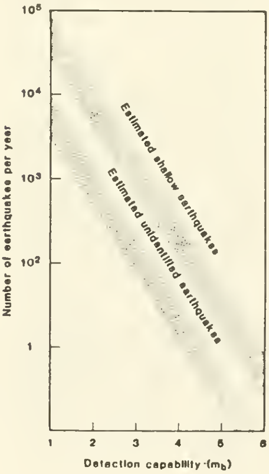


Fig. 8. Plot of Rayleigh-wave amplitude as a function of body-wave magnitude for small to medium seismic events in the western United States (*17*).

The estimate for networks with 15 array stations is that they could, with 90 percent confidence, detect cavity-decoupled events with yields of 3 to 10 kt [1 to 4 kt with 30 percent confidence (Figs. 5 and 9)], depending on the bias used. Some events in these ranges would not be identified, and the 90 percent confidence level for identification may include events twice as large. (However, it may be impossible to construct suitable, stable cavities for such large events.

Cavities sufficient to fully decouple 1-kt explosions would have volumes of 40,000 to 100,000 cubic meters, depending on the material in which they are constructed. Salt domes are especially attractive because of the volume of homogeneous, easily mined material that they contain. Assessments of the extent of salt domes and regions with thick, bedded salt (Fig. 7) indicate that opportunities for decoupling small events in salt cavities are widespread throughout the Soviet Union (*27*). To construct new cavities without suspicion would require suitable cover operations.

The advance of cavity-construction technology in various media (*28, 29*) significantly increases the area suitable for cavity decoupling. Many cavities are



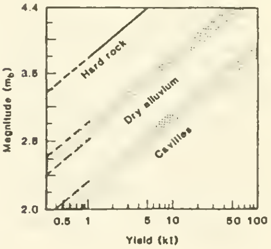


Fig. 9 (left). The annual number of shallow seismic events above a given magnitude varies with magnitude (upper band). We assume at least 20 percent of the detected events within 0.5 magnitude units of the overall detection threshold (especially those closest to the threshold) will not be identifiable (lower band). Fig. 10 (right). Seismic magnitude as a function of yield for different explosion environments. On the basis of data from the Nevada Test Site. Corresponding magnitudes for Soviet explosions could be several tenths higher. Values for yields of less than a few kilotons are extrapolated elongate, with widths narrower than the minimum desired for full decoupling. The overall volumes far exceed the total volume needed, however, and the asymmetry could generate radiation patterns that affect detection (*30*). Soviet regions underlain by suitable rock types for cavity construction are shown in Fig. 7.

It appears that cavity decoupling will significantly challenge CTBT verification of explosions near 1 kt, even with 30 in-country array stations. However, a possible decrease in the decoupling factor at higher frequencies (*31*), together with decreased noise levels at higher frequencies and good propagation of high-frequency seismic waves in some regions of the Soviet Union (*31*, *32*), may make decoupling a less effective evasion tactic. These areas are being actively studied. Also, satellite surveillance may constrain the use of this evasion method in some areas.

Use of Increased Noise Levels

Earthquake signals could be used to mask explosion signals, although this approach lacks the flexibility of location or choice of firing time provided by cavity decoupling. Internal stations markedly decrease opportunities for such masked explosions, but the choice of the right test location could eventually allow detonations of explosions with yields of several kilotons. Choosing the location and detonation time is a significant technical challenge.

Accurate methods for predicting or exciting earthquakes could dramatically increase the usefulness of masking explosions in earthquake noise. At present, neither the United States nor the Soviet Union appears to have the requisite capabilities for large earthquakes, although both are actively involved in disaster prevention research. Periods of naturally occurring or man-made noise could also be used to mask explosion signals. This may seriously degrade the usefulness of low-noise sites for detecting and identifying clandestine explosions (*33*).

On-Site Inspection

The United States considers provisions for on-site inspections necessary for CTBT verification. Although the possibility of on-site inspections increases costs associated with clandestine testing and limits the data that can be collected from such tests, the efficiency of on-site inspections is unknown, and such inspections may not identify a violation identifiable by other means (*34*). Therefore, the role of on-site inspections in verification systems must be considered carefully. They may best be viewed as significant deterrents and a means of reducing false alarms and as providing sufficient but not necessary evidence for declaring a violation.

Conclusions

Seismic verification of a Comprehensive Test Ban Treaty will not ensure identification of all underground nuclear explosions. Political and military considerations must determine the degree of confidence desired of the verification system, what yields and number of tests constitute a militarily significant testing program, and the number of unidentified events that is acceptable, even if unresolved by on-site inspection.

Seismological analyses indicate that networks with 15 high-quality array stations in the Soviet Union could detect events with seismic magnitudes of 3.0 (and down to 2.4 localized regions). Such networks are thought to be capable of detecting cavity-decoupled explosions with 3- to 10-kt yields with 90 percent confidence.

Confident detection of lower-yield explosions would require networks of more than 30 high-quality in-country arrays. The negotiability of such networks is not known. With either the 15- or 30-station network, many events would remain unidentified and, if unresolved, significantly jeopardize continued acceptance of a CTBT.

In reaching these conclusions, enhanced internal station capabilities resulting from the use of multiple regional waves were explicitly invoked and the use of a greatly improved network of in-country seismic arrays capable of detecting and analyzing regional seismic waves was postulated. Three factors determined the conclusions: (i) decoupling cavities may be constructed throughout much of the Soviet Union; (ii) knowledge of signal and noise levels at in-country stations would allow calibration of the stations' ability to detect signals from various locations and the choice of a favorable detonation time—that is, when background noise is high—thus reducing network capability in specific areas; and (iii) because seismicity in the magnitude range 2 to 3 (appropriate for cavity decoupling 1- to 10-kt explosions) can occur in many areas, small unidentified events will pose significant verification problems.

Insufficient knowledge of signal and noise properties in the Soviet Union and the lack of regional discriminants and uncertainties in the magnitude-yield relation at low yields introduce uncertainties in all such calculations. Satellite surveillance may help in identifying cavity construction and high-frequency signals may improve detection capability significantly, but both are currently unproven.

The use of earthquakes to mask explosion signals has not been considered in detail because analysis indicated that cavity decoupling determines the critical properties of in-country seismic networks. However, explosions with yields of several kilotons or more can be hidden by earthquakes. (The long intervals between tests, however, raise questions about the military value of such schemes.) Their usefulness could increase dramatically if earthquake prediction or excitation technologies become available.

Defining and negotiating in-country seismic systems for CTBT verification requires interrelated political, military, and seismological analyses and decisions. Political and military considerations establish performance requirements, and seismology provides technical specifications for the seismic system needed to meet those requirements. The acceptability of specific systems or treaties ultimately is determined by each nation's view of its national security requirements.

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APPENDIX 49

MAY 13, 1983 SCIENCE ARTICLE ENTITLED "SCIENTISTS CHALLENGE CLAIMS OF SOVIET TREATY VIOLATIONS"

Scientists Challenge Claims of Soviet Treaty Violations

The Reagan Administration's judgment that the Soviet Union has violated the Threshold Test Ban Treaty came under renewed attack at a recent meeting of the American Geophysical Union. A number of prominent seismologists, including Lynn Sykes of Columbia University and Charles Archambeau of the University of Colorado, presented studies to support their conclusion that the Soviets have not exceeded the 150-kiloton nuclear testing limit. "The Russians are essentially in compliance, as far as we can tell," Archambeau said.

Although no formal charge of cheating has been lodged with the Soviets, President Reagan has stated that "we have reason to believe that there have been numerous violations" of the treaty (*Science*, 13 May, p. 695). He might have changed his mind after hearing the speakers in Baltimore on 2 June. "Based on what I heard this morning, I think we have a hard time justifying statements that the Soviets are cheating," said Bernard Minster, a Defense Department seismological consultant. "After listening to the presentations . . . most people would agree that you cannot assert that the Soviets have violated the treaty," said Robert North, another consultant.

Support for Reagan's claim was expressed by Ralph Alewine, director of the geophysical sciences division at the Defense Advanced Research Projects Agency (DARPA), and Thomas Bache, a program manager who works for Alewine. They said that the Soviets have detonated nine bombs above the 150-kiloton threshold since the treaty was signed in 1976.

But Alewine conceded that six of these apparently fall between 150 and 200 kilotons and are therefore not of serious concern. "They could be due to miscalculations on either side," he said. Two apparently fall between 200 and 250 kilotons, and one is apparently just over 300 kilotons.

Alewine described the latter detonations as being "egregiously above the limit." But he noted that the Soviets would be well within their rights "if they just said sorry we made a mistake." A provision of the treaty permits one or two accidental breaches of the threshold per year. Eugene Herrin, a seismologist at Southern Methodist University who chairs a DARPA advisory panel, has argued that all of the apparent Soviet violations could be due to such accidents, U.S. miscalculations, or both.

In any event, similar accidents occur at the U.S. test site, albeit less frequently. Alewine and Bache reported that in the same period two tests in Nevada have exceeded the treaty limit by 33 and 75 percent, respectively.

Milo Nordyke, who directs the verification program at Lawrence Livermore National Laboratory, where the bulk of the government's analysis is conducted, said after the AGU meeting that "DARPA, which takes the most conservative view, certainly seems to be in the minority. Of course, with the conservative view, you automatically get some evidence of Soviet violations. But you have to use the best estimate, not the most conservative one. This is a message that the politicians in Washington have a hard time understanding."

—R. JEFFREY SMITH

APPENDIX 50

NOVEMBER 1984 SCIENCE ARTICLE ENTITLED "THE WASHINGTON-MOSCOW SEISMIC HOT LINE" [1]

AN INTERNATIONAL EXPERIMENT INVOLVING EXCHANGES OF SEISMIC DATA IS THE LATEST EVIDENCE OF SCIENTIFIC PROGRESS ON NUCLEAR TEST BAN VERIFICATION

(By R. Jeffrey Smith)

The first message from the Institute of Physics of the Earth, located on the outskirts of Moscow, arrived in the United States on the morning of 17 October. Under the heading of SERS1 RUMS 171000., a list of numbers and phrases offered a detailed description of the local seismic signals created by a large earthquake in the South Pacific. Sent by satellite via Czechoslovakia, West Germany, and England, this information was received at a modern office building in suburban Washington. There, it was interpreted within hours by a team of seismologists at a research center financed and operated by the U.S. Department of Defense. On the previous day, similar seismic data, collected at six stations in the United States and Canada, had been sent to Moscow.

This extraordinary exchange is only the first of many scheduled before mid-December, as seismologists in 34 countries participate in a novel 3-month experiment organized by the Conference on Disarmament in Geneva. The purpose of the experiment is to rehearse a key mechanism for verifying compliance with a comprehensive ban on nuclear weapons tests. It was hatched more than 4 years ago, when worldwide interest in such a ban was at its peak, and negotiations were moving rapidly toward a successful conclusion. Given the failure of those negotiations to date, and the bleak outlook for their future, the experiment's very existence is a noteworthy achievement.

Although formal test ban negotiations began more than 20 years ago, the effort has been stalled largely because of Western desires to build new and better nuclear weapons (see box). This opposition is strengthened by a pervasive conviction that treaty compliance by the Soviet Union would be extremely hard to verify. The importance of the experiment stems from its relevance to the second of these problems. If it succeeds, it will go a long way toward establishing the viability of a verification systgem in which the entire world may join. At a minimum, it will result in the international exchange of unusually detailed scientific information. It will serve, moreover, as an example of other progress on the test ban verification problem and as a reminder that the major roadblocks in the path of a treaty are political—not technical.

The underlying theory of this verification mechanism is simply that nuclear explosions beneath the earth's surface generate characteristic seismic signals, and that a systematic worldwide effort to gather and exchange detailed seismic data will diminish the likelihood that such signals go undetected. Seismic data received and reported by Sweden, for example, will be contrasted with those reported by East Germany, Egypt, Peru, Japan, and Australia, in hopes of pinpointing the origin and character of a suspicious "seismic event," or disturbance of the earth's natural vibrations.

In order to widen participation and improve the system's reliability, the United States has made substantial efforts to provide as many countries as possible with the necessary sensors: earlier this year, it even shipped a copy of the analytical software to the Soviet Union. The protocol for the experiment, which was hammered out in Geneva last summer, stipulates that participants must attempt to record 52 different seismic measures for any event. The data are then transmitted daily through an existing Telex network originally designed for the international exchange of meteorological data. The result is that detailed seismic readings become available in an unusually short period in three specially designated centers in Washington, Moscow, and Stockholm.

In Washington, both domestic and international data are collected at the $5 million Center for Seismic Studies, created in 1982 by the Defense Advanced Research Projects Agency (DARPA) in order to gather data on Soviet nuclear weapons tests. Signals are received by six sensors, situated on prime geological territory in California. Ontario, South Dakota, Alaska, Texas, and New York. The most modern of these are ingeniously compact and largely self-sufficient, requiring only occasional replenishment of propane fuel to power a thermoelectric generator. The heart is a slender steel column buried 100 meters below the earth's surface, containing two seismometers and equipment capable of transforming the data into digital computer signals. Atop each column is a small satellite antenna for direct broadcast of the results.

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As the the signals flow into the Seismic Study Center's modern offices in Rosslyn, Virginia, three high-speed VAX computers scan automatically for unusual activity, and displays the results on a sophisticated console in an adjacent room. (Although the same computers also store classfied data from seismic stations operated in secret by the U.S. Air Force, the National Security Agency has written software that effectively bars disclosure to those without appropriate clearance.) Specially trained analysts sift through the data, fixing the time, location, magnitude, and character of specific events with the aid of extremely detailed geologic and seismic information stored in the computer memory banks.

A seismic event in the Soviet Union, for example, is triangulated and then contrasted with relevant historical information. An explosion may be distinguished partly by the richness of the high-frequency energy it creates, partly by the shallow depth of its starting point, and partly by a characteristic regional expansion of the earth's surface. Errors are uncovered through vigorous crosschecking with data disturbed by the two other centers (a fourth center is planned for Melbourne). "In wide use, systems capable of analysis such as this will really help us to understand the patterns of earth tectonics," says Ralph Alewine, director of DARPA's geophysicial sciences branch and one of the experiment's primary organizers.

He cautions, however, that even though the structure of the system being tested is identical to that envisioned for a test ban treaty, the United States would prefer under a real agreement to exchange more detailed information, such as computerized replicas of the seismic waveforms themselves, and to incorporate more modern sensors and communications equipment in the international network.

A relative lack of interest and funds on both sides combined to limit the sophistication of the experiment, according to Charles Archambeau, a professor of geophysics at the University of Colorado who is a visiting scholar at DARPA's center this year. "The exercise is actually rather primative, when you compare it with what we would really like to do," he says. "These people have knocked themselves out, but it isn't as if our government has said, 'Let's go full bore and demonstrate our interest in a comprehensive test ban.' In fact, the government is not interested in such a ban, and it shows." He claims that the center is terribly understaffed and that related seismic research is seriously underfunded. "It's hard to extract money for this effort from ongoing defense programs," he says.

Ironically, DARPA's expenditures on geophysics research have decreased by $1.7 million in the 2 years since the Reagan Administration formally withdrew from the comprehensive test ban negotiations, citing the need to improve verification. Elsewhere, there have been sharper cuts. The Arms Control and Disarmament Agency (ACDA), for example, today spends one-tenth of the funds on nuclear test ban research that it did in 1979, during the negotiations.

Then, both sides agreed on a system of verification that would include not only the mechanism presently being tested, but also a system whereby the United States could place its own seismic sensors on Soviet soil, and the Soviets could do the same on U.S. territory. Both sides also agreed to allow on-site inspections to investigate suspected weapons detonations. Since the talks adjourned, Alewine says, the United States has substantially improved the technology on which these verification systems will depend. It has honed its techniques for discriminating between earthquakes and explosions. And it has developed dramatic new evidence that even surreptitious, low-yield explosions—perhaps as low as a kiloton or so—may be detected at a considerable distance.

According to Alewine, the new evidence comes from Kjeller, Norway, where DARPA and the Royal Norwegian Council for Scientific and Industrial Research are cooperating in a test of extraordinarily sensitive seismic sensors, developed specifically to capture the high-frequency signals created by decoupled nuclear explosions. (A decoupled explosion is one that might occur inside a huge undeground cavern, such as a salt mine, which absorbs a good portion of its energy; their threat has long been the bane of treaty verification.) Thus far, the performance of the sensors, situated in a logarithmically speced array. "is much better than we predicted." Alewine says. "They have picked up some incredibly small signals, and our ability to pinpoint the origin has improved by more than an order of magnitude."

Archambeau is even more enthusiastic, describing the new sensors as "maybe the breakthrough we've ben waiting for." Along with Jack Evernden, a seismologist at the U.S. Geological Survey, he believes that placement of 25 of them in the Soviet

Union could permit verification of an extremely low test limit. James Hannon, the program manager for seismic monitoring at Lawrence Livermore National Laboratory, says of the tow researchers that "they're probably pretty close as far as seismic detection is concerned, but I am not sure about discrimination, and they've not proven that it's possible to find 25 sites with extremely low background noise in the proper distribution for a national monitoring network." After additional reflection. Hannon said that he is uncertain whether even a single low-noise site could be located.

Hannon suggests that terms of researchers conduct a systematic search for the requisite sites in the United States. "It would give us more confidence before we went to the Soviet Union with a proposal," he says. "If you can find these sites, it might indeed be a whole new ball game." He adds that the search could be conducted over 3 years at a cost of $10 million, but that with additional funds it could be completed somewhat sooner. Even Thomas Etzold, a test ban opponent who directs the multilateral affairs bureau at ACDA, agrees that "there is enough here so that we ought to be looking at it seriously."

While great strides have ben made by the scientists, little has been accomplished by the politicians. Although some differences remained after the last round of bilateral negotiations—about such topics as the scope of an on-site inspection or the frequency and means of communication with seismic sensors—participants from both countries were optimistic that they could be resolved. Vladimir Shustov, who has followed the negotiations for the Soviet foreign ministry since 1959 and is now a deputy permanent representative to the United Nations in New York, says that "from the Soviet viewpoint, 90 percent was agreed upon with regard to verification." Paul Warnke, who was ACDA's director throughout much of the recent negotiations, says that a final agreement was just around the corner "when political pressures began to force a retreat." He characterizes the U.S. withdrawal from the talks as "a classic example of our unwillingness to take yes for an answer."

Now, in a multilateral forum, the talks have ground to a halt. Members of the Conference on Disarmament departed from the last session in utter disarray, unable to come to a simple agreement about the charter for the test ban working group. A group of 21 nations, led by Mexico, proposed that the group be charged with "the multilateral negotiation of a treaty," while the Socialist countries proposed that the group "carry out practical negotiations with a view to elaborating a treaty." The United States rejected both, and insisted that the group examine "substantive issues . . . with a view to negotiation," a compromise position that prompted considerable grumbling from diehard U.S. test ban opponents. No single view has yet prevailed. and the Conference, which operates by consensus, remains immobilized.

Some verification experts, such as Milo Nordyke at Livermore, are pessimistic that the remaining U.S.-Soviet differences may be easily resolved. The Soviets may not agree to search for 25 extremely quiet seismic sensor sites, he says. They might insist on a total test ban, not merely a limit of 1 or 2 kilotons. They might also oppose an indefinite moratorium on peaceful explosions. Shustov, of the Soviet Union, is vague about potential compromises on these topics, indicating only that "if the Western side were ready to finalize bilateral negotiations, we would be ready to go along." Actually, he says, "in this venture, we are ready to have bilateral, trilateral, or multilateral exchanges, All the talks about the complexity of verification are artificial ones. Our scientists are convinced that it is possible to verify a [comprehensive test ban], and there are no insurmountable difficulties about this."

He suggests that the Soviet Union would be willing to renew the negotiations even if Reagan declines to seek Senate ratification of the related Threshold Test Ban Treaty and the Peaceful Nuclear Explosions Treaty. "In my position it is difficult to give you a direct answer." he told *Science* recently. "But two things I can tell you very definitely. First, we would like to use all means for reaching an agreement on a comprehensive test ban. If there were sound proposals on the other side . . . and if they appeared to facilitate an agreement, I think we would view them positively. Second, we consider the ratification of what is already agreed upon to be useful." But he hints that the Soviet Union will oppose further activity by the Conference on Disarmament's scientific group if negotiations do not occur soon. "If the scientific discussion and experiment are used as a substitute for negotiation and agreement, then certainly this situation will be unacceptable," he says.

Clearly, the Soviet Union's commitment to a treaty will be measured in part by its performance in the ongoing experiment. Alewine is not encouraged by the fact that data are being sent by only one Soviet station, and that it somehow failed to pick up seismic signals generated by two Soviet nuclear explosions in late October. But a final assessment of their participation must await the next international meeting of the scientific group in March.

In the meantime, the test ban issue will probably attract renewed political attention. On the last day of the 98th Congress, Representative Dante Fascell (D-Fla.), the House Foreign Affairs Committee chairman, excoriated the Reagan administration for withdrawing from the negotiations and announced that he intends to conduct a series of hearings on the test ban next spring. Representatives of nuclear freeze groups have also stated that a test ban will be at the top of their agenda next year.

Since the termination of formal negotiations, virtually the only activity in this area has been scientific, and most of the participants believe that their efforts have borne fruit. Hans Israelson, the delegate from Sweden to the Conference on Disarmament's Ad Hoc Group of scientific Experts, says that treaty verification is no longer an indecipherable problems. "It is a political issue," he says. "It hangs on whether you'd like to have the opportunity to test." Only when both sides agree to forgo this opportunity, will a treaty finally be reached.

THE ALLURE OF NUCLEAR TESTING

On 19 July 1982, at a meeting of the National Security Council, President Reagan formally decided to end U.S. participation in international efforts to ban all nuclear tests. In so doing, he eschewed a foreign policy goal of five previous administrations without immediately providing a clear explanation. News of the decision came not in a presidential statement or address but in a leak to a newspaper. Reporters were subsequently briefed by two Administration officials who insisted that their names not be disclosed. Vaguely, they indicated that talks had been halted largely out of concern that compliance with a test ban could not be adequately verified, and added that no talks would resume until the verification provisions of two existing treaties no nuclear testing, already signed by the United States and Soviet Union, could be renegotiated.

No one doubts that verification of a test ban treaty is a major Administration concern. But the primary reason for the decision to withdraw from the negotiations is clearly a powerful desire to continue testing new warheads. As the Arms Control and Disarmament Agency (ACDA) admitted to Congress in 1983, a test ban "continues to be a long-term U.S. objective, [but] nuclear tests are specifically required for the development, modernization and certification of warheads, the maintenance of stockpile reliability, and the evaluation of nuclear weapons effects."

In a recent interview with *Science*, Thomas Etzold, director of the multilateral affairs bureau of ACDA, expanded on this argument and said that a test ban has been rejected primarily because it would interfere with the development of exotic new weapons, including those needed for Reagan's recent "Star Wars" plan. He also specifically denied that the successful renegotiation of related testing treaties is a precondition for renewing talks about a comprehensive ban.

Etzold is the official with direct responsibility for the Administration's test ban policy, because ACDA fields the U.S. delegation to the Conference on Disarmament in Geneva. A former history professor at the Naval War College and Miami University, he came to the agency last May from the Center for Naval Warfare Studies, where he was involved in nuclear weapons planning and war gaming. He argues first that a potential benefit of a test ban—the barrier it might erect to the acquisition of a nuclear weapon by a Third World country—has been vastly overstated. "Frankly," he says, "it amazes me that 40 years after the first explosion, people still imagine that you need to conduct a test to have a nuclear weapon. Testing is simply not the crucial component of weapons development anymore." Treaty advocates argue, however, that if the bomb's intended use is political, not military, then a test ban might limit its attractiveness by denying the builders any chance to demonstrate their skills, short of actual combat.

Drawing a distinction between the initial development of nuclear weapons and their later refinement, Etzold argues next that testing is essential to modernization, and that a test ban is therefore not in U.S. interests. "When you think about the things that would make it possible for you to have fewer warheads and still meet your military needs under different scenarios, you think of things like . . . better control of how and where these things detonate . . . different combinations of blast and radiation effects, creating sustained instead of short-term effects, and so on. The problem we face now is that a great number of our friends as well as our adversaries would like to have a test ban of the sort that would preclude modernization. They think that qualitative improvements in weapons means that the arms race gets more acute. But they're missing a fundamental point here: that modernization is a way to get to lower numbers [of weapons] and that a reduction in numbers permits us to contemplate the transition from primary reliance on offensive weapons to primary reliance on defensive weapons." Modern warheads are generally more efficient than older designs, so fewer are needed to accomplish the desired effect, Etzold explains.

Modern warheads also generally use less fissile material, he says. "If people care about how much money gets spent on defense, they ought to care about this. If they care about how big the nuclear waste management problem is, they ought to care about this. If they are concerned about the cost of refurbishing a weapons system due to the decay of radioactive elements, they ought to care about this." In addition, he adds, modern warheads typically have lower yields, because they are more apt to hit their targets and therefore require less explosive force. Without testing, he concludes, the United States would be stuck with "large but inefficient inventories, dirty bombs, expensive warheads . . . [and] longer lasting, more widespread environmental effects in the event of nuclear employmnent." Treaty advocates such as Sidney Drell, codirector of Stanford's Center for International Security and Arms Control, disagrees. They argue instead that adequate safety and efficiency improvements have already been made, that the Soviets are presumably behind in warhead yield-to-weight ratios, and that a test ban could freeze in place an existing U.S. advantage.

Finally, Etzold argues that test ban verification problems are indeed serious. "There's a hell of an argument over whether or not a little bit of cheating on low yield tests is militarily significant, whether it should matter to us. My view is that it would. And we are not at a point where such a test regime could be confidently monitored." But even if the verification problems are resolved, he adds, "we still have to reach agreement on what it is we're trying to arrive at. By this I mean there's a lot of confusion over whether some total universal ban is necessary or whether you really only want to keep this down to some low yields. I think we should [only] have a regulated testing regime, because if you want to get this problem under control, if you want to seek lower and lower yields, the way you do this is not by quitting all testing."

Asked what yield would be acceptable as a upper boundary for U.S. nuclear tests, Etzold demurs, "I can't give you a number. All I can say is that there is one hell of a debate going on. I wouldn't rule out the possibility that some people think 150 kilotons is too low." One hundred and fifty kilotons is the limit presently imposed by the Threshold Test Ban Treaty, which was signed by President Ford but never submitted for Senate ratification. Despite the differences in U.S. and Soviet views on nuclear testing limitations, Etzold hopes that the United States and the Soviet Union "will be well along in the direction of an agreement" by the end of the decade.

APPENDIX 51

ARTICLE FROM AUGUST 13, 1982, CHRISTIAN SCIENCE MONITOR ENTITLED "N-BOMB TESTS: IT'S EASIER TO VERIFY A TOTAL BAN"

(By Michael B. Berger)

The Reagan administration recently announced its intention to postpone talks on the Comprehensive Nuclear Test Ban Treaty (CTBT) until verification problems related to nuclear test limitation treaties can be resolved. The administration has failed to recognize, in public, that a complete test ban and test limitations are two different propositions. It is much easier to monitor compliance with a total test ban than with test limitations. Thus the argument that a test ban treaty must await solutions to the problems of verifying test limitations is spurious.

In truth, the administration's espoused concern about verification is a subterfuge, meant to deflect attention from the fact that nuclear testing is an integral component of the President's arms buildup.

Any arms control treaty or agreement involves the risk that signatories might choose to violate the treaty clandestinely, and succeed. In order to minimize another country's incentives and opportunities to violate an arms control agreement secretly, the United States employs a variety of means: satellite surveillance, radar, seismic sensors, electronic monitors, and human intelligence collection. These verification capabilities are designed to detect actual violations and, more important, deter potential violators by increasing the probability that noncompliance will be detected.

Each party to an arms control agreement must consider the trade-off between risks and benefits: Do the risks of undetected noncompliance outweigh the benefits of compliance? A recent Congressional Research Service report states ". . . it is generally held that no . . . agreement is completely verifiable. The question becomes how much uncertainty can be accepted in exchange for an agreement, as opposed to demanding complete verifiability, which would preclude any agreement."

When examined in terms of risks and benefits, the increase in our national security that the CTBT offers far outweighs the very limited risk of failing to detect noncompliance.

The risks associated with a test ban agreement are smaller than those associated with other types of proposed arms control treaties, i.e., START, chemical weapons, etc. There is general agreement that modern seismic verification capabilities permit the detection of even very low yield nuclear test explosions. The problem is to distinguish between seismic signals from smaller tests and those of natural seismic events, and thus to identify a particular seismic event as either man-made or natural. The CTBT would require the Soviets to explain all ambiguous seismic occurrences, thereby resolving the identification problem. As the size of a test exceeds five to ten kilotons, the probability of detecting and identifying nuclear explosions dramatically increases.

The most recent round of CTBT negotiations (completed in November 1980) made considerable progress on verification issues. Britain, the US, and the USSR agreed to place ten tamperproof seismic sensors on the territory of both the US and the Soviet Union. (The number to be located in the United Kingdom was not decided.) Data from these stations would be monitored by all parties to the treaty, and by an independent panel of international seismic experts.

The three countries also agreed on a framework for resolving disputed seismic and surveillance data, including on-site inspection in disputes which cannot be satisfactorily settled through additional data exchange and discussion.

What would be the consequences of Soviet testing if our verification measures failed? The yields of clandestine tests would have to be small, below approximately five kilotons, to avoid seismic detection. Five kilotons is one-thirtieth the size of the smallest Russian warhead currently deployed, and one-hundredth the size of the standard Soviet strategic warhead. Clearly, such tests would provide the Russians with little useful information about full-size weapons.

In addition, because significant military results are likely to be achieved only from a series of tests, rather than from a single test, multiple tests would substantially increase the likelihood of detection.

In sum, the chances of failing to detect Soviet violations of the comprehensive test ban are very small.

The benefits of the CTBT are threefold.

First, the CTBT would severely inhibit the proliferation of nuclear weapons to the "near nuclear" countries (Argentina, Brazil, India, Israel, Pakistan, and South

Africa). An agreement signed by the three nuclear superpowers would put heavy domestic and international pressure on these states to refrain from testing. Since all countries that have developed nuclear weapons have found it necessary to test prior to reaching full nuclear capability, the CTBT, by inhibiting testing, would curb the "horizontal proliferation" of nuclear weapons.

Second, concluding the CTBT would increase America's credibility in the world political community. In the Limited Test Ban Treaty of 1963, the US, USSR, and Great Britain pledged to "achieve the discontinuance of all test explosions of nuclear weapons for all time" and stated that the parties were "determined to continue" negotiations to this end." Therefore, a test ban treaty would redeem an American promise that has been outstanding for 19 years.

Third, the CTBT would halt the momentum of the arms race in both the US and Russia. A ban on all testing would prevent further improvements in warheads that might be used in future weapons systems. It would also establish a better climate for the current Strategic Arms Reduction Talks (START) and Intermediate Range Nuclear Forces (INF) negotiations.

By dropping the comprehensive test ban negotiations, the administration has discarded its most useful tool for checking nuclear proliferation. President Reagan would demonstrate true statesmanship by reversing his position and calling for an early resumption of them.

Michael B. Berger is director of the 1983 International Student Pugwash Conference and staff associate at the Committee for National Security's Comprehensive Test Ban Task Force.

APPENDIX 52

ARTICLE FROM APRIL 28, 1985, NEW YORK TIMES ENTITLED "EX-LEADERS ASK ATOM TEST BAN DURING ARMS TALKS" [1]

(By Paul Lewis)

PARIS, April 27—A meeting here of former government leaders from 24 countries today urged a total ban on nuclear testing for the duration of the current Geneva arms talks and new steps to strengthen the world's monetary and trading arrangements.

The declaration was signed by former leaders from the West, the developing nations and several communist countries. Their goal is to influence the outcome of the Western economic meeting in Bonn next week as well as the Geneva talks between the Soviet Union and the United States.

The former leaders were attending the third meeting of the Interaction Council of Former Heads of government. Members try to use their prestige and contacts to encourage the world's political leadership to adopt policies favored by the Interaction Council.

Western members who attended the session today included former Chancellor Helmut Schmidt of West Germany and former Prime Ministers Takeo Fukuda of Japan, Pierre Elliott Trudeau of Canada, James Callaghan of Britain and Malcolm Fraser of Autralia.

Members from the developing world included former Presidents Carlos Andrés Pérez of Venezuela and Misael Pastrana Borrero of Colombia, and the former Nigerian head of state, Gen. Olusegun Obasanjo, and the former Prime Minister of Zambia, Mathias Mainza Chona.

The Communist world was represented by former Prime Ministers Jeno Fock of Hungary and Mitja Ribicic of Yugoslavia and former Foreign Minister Huang Hua of China.

VISITS TO CAPITALS PLANNED

Kurt Waldheim, the former United Nations Secretary General, who was chairman of the meeting, said at a news conference that members of the council would visit governments around the world to press the policy recommendations made today.

After strongly supporting the nuclear arms talks in Geneva, the former leaders called on nuclear powers to suspend all weapons testing while the talks continue. Such a ban, they said, would "instill greater confidence" into the negotiating process. A widely accepted 1963 treaty bans nuclear weapons tests in the atmosphere, in outer space and underwater, but not underground.

Turning to the economic meeting in Bonn next week, the former government leaders said the world's economic difficulties could be resolved only by simultaneous action to strengthen the monetary system, free international trade and deal with the third-world debt crisis.

They strongly endorsed President Reagan's call for a new international trade-freeing negotiation to defuse growing protectionist pressures.

But council members also agreed with France that freer trade makes little sense when currency values remain highly volatile. Accordingly, they endorsed the call by President Francois Mitterand for moves to stabilize the dollar and other major currencies.

CITE STARVATION IN AFRICA

Turning to the economic crisis in the poorest developing countries, the council said 30 million people were facing starvation in Africa alone. In addition to increased food and development aid for these countries, the council called on Western governments to convert loans into grants and take more exports.

But it also urged developing nations to pay more attention to building up their agriculture.

The Interaction Council was set up in 1983 to mobilize the experience, contacts and skills of former leaders. It has a budget of $1.5 million a year, now financed by contributions from Japan, Austria, Norway, Sweden and Colombia and private contributions.

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Its 30 members include former government leaders from all major parts of the world except the United States and the Soviet Union. Mr. Waldheim said the council was "in contact" with former President Gerald R. Ford and was talking with the Soviet Union about a possible Russian member.

APPENDIX 53

ARTICLE FROM DECEMBER 12, 1983, NEW YORK TIMES ENTITLED "SMALL RISK FOR BIG GAINS" [1]

(By Tom Wicker)

The United Nations resolved last week, by a vote of 111 to 1 with 35 abstentions, that all nuclear tests should be outlawed. The opposing vote was that of the United States, with Deputy Representative Kenneth L. Adelman repeating the ritual position of the Reagan Administration:

"While a prohibition on all nuclear explosions remains a long-term United States objective, the United States does not believe that, under present circumstances, a comprehensive nuclear test ban would reduce the threat implicit in the existing stockpile of nuclear weapons."

Translation from Reaganese: the Administration does not want a test ban to interfere with its projected nuclear buildup, which will include thousands of new warheads and is designed to overcome what Mr. Reagan insists against the evidence is Soviet nuclear superiority.

But that "long-term objective" Mr. Adelman so casually dismissed is in fact a 20-year, binding American commitment to achieve a comprehensive nuclear test ban. In the Limited Test Ban Treaty of 1963, both Washington and Moscow pledged themselves "to achieve the discontinuance of all test explosions of nuclear weapons for all time." The Nuclear Non-Proliferation Treaty includes a similar pledge. In the U.N. last week, the Soviet Union voted to honor those commitments; "under present circumstances," the U.S. did not.

It was this country, moreover, that in 1980 backed away from a comprehensive test ban (CTB) treaty with the Soviet Union and Britain, after it had been largely agreed to. That treaty included unprecedented Soviet concessions, including seismic monitors on Soviet territory and the principle of on-site inspections.

But opposition from the Joint Chiefs of Staff and the nuclear weapons establishment was fierce; and the Soviet invasion of Afghanistan then prevented completion of the treaty. Last summer, President Reagan said the U.S. would not resume negotiations for a CTB—hence Mr. Adelman's U.N. vote against a solemn U.S. commitment.

He cited as one reason the supposed problems of verification. But verifying a test ban is much easier than verifying an arms control agreement; seismic techniques are constantly being improved; and any low-yield testing that might go undetected would be of little weapons development value. Moscow's opening of its territory to on-site inspection seems well worth this small risk.

Another objection is the diminution in reliability of existing nuclear weapons that might result from lack of testing; critics fear this could mean a decline in the deterrent power of U.S. forces. But a loss of weapons reliability would equally impair any other nation's confidence in its ability to launch a successful nuclear attack. Besides, in the maintenance of reliability, if not in development, new scientific techniques might partially compensate for the lack of tests.

The deepest fear of CTB opponents is that the U.S. cannot compete with the Soviets in conventional forces, and therefore must rely on nuclear weapons and the threat of nuclear retaliation to maintain American security. But a test ban would reduce Soviet-American tensions and put a cap on the growing size and sophistication of superpower nuclear arsenals, reducing the likelihood of their eventual use. And reliance on nuclear forces is not a useful answer to regional but vital security problems in, say, the Persian Gulf area.

The spread of nuclear weapons to other nations is another profound threat to American security; a CTB treaty would be of overriding importance in stopping such proliferation. Near-nuclear powers like Brazil, India, Israel and South Africa have refused to sign the non-proliferation treaty but are committed by their ratification of the Limited Test Ban Treaty to accept a comprehensive test ban. Without CTB, one or more of them is all too likely to move on soon to full membership in the nuclear club.

A different kind of problem would be presented by France and China, if they refused to observe a CTB; the Soviets, in particular, could hardly be expected to discontinue testing if the Chinese did not. Barry Bliechman, a former official of the Arms Control and Disarmament Agency, has suggested that this problem could be met by a CTB limited to a specified period during which, if any nations continued to test, treaty signatories could reevaluate their positions.

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Besides, as the Center for Defense Information pointed out in its November news letter, no nation agreeing to a test ban could be expected to continue observing it if others refused or violated treaty terms; and determining such violations would be a matter of each nation's judgment.

A CTB treaty—so nearly within reach already—therefore offers only small risks for large potential gains. Mr. Reagan won't pursue them voluntarily, but Congress by joint resolution could put severe pressure on him to do so. That would be a sensible sequel to the House vote against the MX.

APPENDIX 54

Article From August 5, 1984, New York Times Entitled "Forty Years After"

Forty Years After [1]

TIME FOR A FRESH ATTEMPT TO BAN ALL NUCLEAR TESTING

Thirty-nine years ago this week, on Aug. 6, 1945, the Enola Gay opened its bomb bay doors over Hiroshima, and the United States became the first and only nation to use nuclear weapons against another. On this somber anniversary, a public campaign is being launched to achieve an end to all nuclear explosions by the time of Hiroshima's 40th observance in 1985.

Such a campaign is not as far-fetched as it may sound. Once before, beginning in the Eisenhower Administration, a moratorium on all nuclear testing was observed by the United States and the Soviet Union. Twice before, in the Kennedy and Carter Administrations, a comprehensive test-ban treaty (C.T.B.T.) was nearly achieved.

The Kennedy effort ended in the Limited Test Ban Treaty, banning nuclear explosions in the atmosphere. The Carter negotiations were virtually complete, with the Russians agreeing to on-site inspections for verification, when Moscow's invasion of Afghanistan and the resistance of the U.S. military and the national nuclear laboratories scuttled the treaty.

Then Ronald Reagan took office and began a nuclear buildup that caused him to renounce any intention of negotiating a test ban. Mr. Reagan therefore gave the back of his hand to the legal treaty commitments his predecessors had undertaken. In the Limited Test Ban Treaty of 1963 and later in the Non-Proliferation Treaty (N.P.T.) of 1970, both ratified by the Senate, the United States had solemnly pledged its best efforts to bring about an end to nuclear testing.

Renewed nuclear proliferation is one good reason to bring public pressures on Mr. Reagan—if he should be re-elected—to seek a comprehensive test ban. At their last review conference in 1980, N.P.T. signatory nations warned that if the nuclear powers did not make progress toward ending nuclear tests by the time of their next conference in 1985, some might withdraw from the N.P.T. and resume nuclear weapons development. But the only thing that's been done about nuclear tests has been to conduct more of them here in the United States and in the Soviet Union.

Nonproliferation is only one reason, Dr. Glenn T. Seaborg of the University of California, who was the head of the Atomic Energy Commission under Presidents Kennedy and Johnson, observes in a statement supporting the new drive for a comprehensive test-ban treaty that such a treaty would "halt that aspect of the arms race that is most threatening, the qualitative improvements in nuclear weapons."

A relatively simple step to take and enforce a C.T.B.T., as Dr. Seaborg points out, also would produce "new momentum" in more complex arms-control negotiations. And such a treaty might open the way for improved Soviet-American relations across the board.

Dr. Seaborg prepared his remarks for a Washington news conference to be held on Aug. 6 at which the new C.T.B.T. campaign will be announced by the Center for Defense Information, which hopes to generate world-wide support. W. Averell Harriman, the American negotiator for the Limited Test Ban Treaty, and numerous scientists and scientific organizations also are expected to register their backing.

Walter Mondale, the Democratic Presidential nominee, announced in the spring that if elected he would observe a moratorium on nuclear testing as long as Moscow did, as a step toward renewing negotiations for a comprehensive test ban.

The predictable opposition will center, first, on the supposed difficulties of verification. But aside from the Soviet Union's stated willingness to accept on-site inspection, the scientific evidence is overwhelming that nuclear tests above one kiloton in magnitude (smaller explosions have little value for weapons development) can be detected by seismic means.

Opponents also will argue, as before, that testing is necessary to keep weapons in the nuclear stockpile in working order. In fact, "meticulous inspection and disassembly" have been the main reliance for such checkups, a former director of the Los Alamos laboratory has testified.

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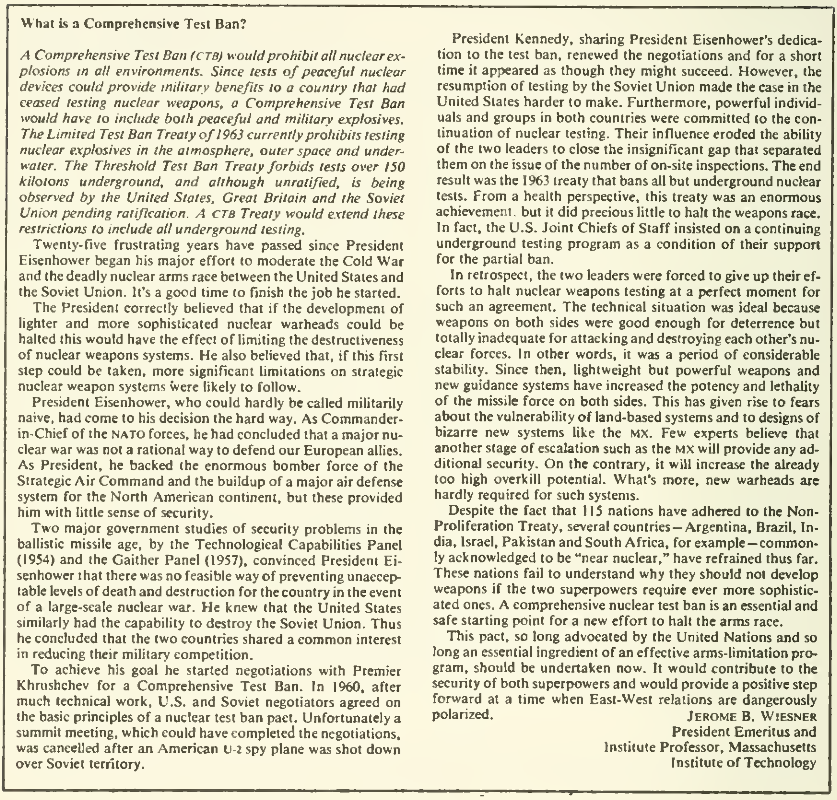
These spurious arguments have prevailed in the past. But the real reason for testing is to develop and improve nuclear weapons; and the best reason for a comprehensive test ban is to put a stop to that, here, in the Soviet Union and anywhere else it might be contemplated.

APPENDIX 55

June/July 1982 Bulletin of the Atomic Scientists Article Entitled "What is a Comprehensive Test Ban?"



What is a Comprehensive Test Ban?

A Comprehensive Test Ban (CTB) would prohibit all nuclear explosions in all environments. Since tests of peaceful nuclear devices could provide military benefits to a country that had ceased testing nuclear weapons, a Comprehensive Test Ban would have to include both peaceful and military explosives. The Limited Test Ban Treaty of 1963 currently prohibits testing nuclear explosives in the atmosphere, outer space and underwater. The Threshold Test Ban Treaty forbids tests over 150 kilotons underground, and although unratified, is being observed by the United States, Great Britain and the Soviet Union pending ratification. A CTB Treaty would extend these restrictions to include all underground testing.

Twenty-five frustrating years have passed since President Eisenhower began his major effort to moderate the Cold War and the deadly nuclear arms race between the United States and the Soviet Union. It's a good time to finish the job he started.

The President correctly believed that if the development of lighter and more sophisticated nuclear warheads could be halted this would have the effect of limiting the destructiveness of nuclear weapons systems. He also believed that, if this first step could be taken, more significant limitations on strategic nuclear weapon systems were likely to follow.

President Eisenhower, who could hardly be called militarily naive, had come to his decision the hard way. As Commander-in-Chief of the NATO forces, he had concluded that a major nuclear war was not a rational way to defend our European allies. As President, he backed the enormous bomber force of the Strategic Air Command and the buildup of a major air defense system for the North American continent, but these provided him with little sense of security.

Two major government studies of security problems in the ballistic missile age, by the Technological Capabilities Panel (1954) and the Gaither Panel (1957), convinced President Eisenhower that there was no feasible way of preventing unacceptable levels of death and destruction for the country in the event of a large-scale nuclear war. He knew that the United States similarly had the capability to destroy the Soviet Union. Thus he concluded that the two countries shared a common interest in reducing their military competition.

To achieve his goal he started negotiations with Premier Khrushchev for a Comprehensive Test Ban. In 1960, after much technical work, U.S. and Soviet negotiators agreed on the basic principles of a nuclear test ban pact. Unfortunately a summit meeting, which could have completed the negotiations, was cancelled after an American U-2 spy plane was shot down over Soviet territory.

President Kennedy, sharing President Eisenhower's dedication to the test ban, renewed the negotiations and for a short time it appeared as though they might succeed. However, the resumption of testing by the Soviet Union made the case in the United States harder to make. Furthermore, powerful individuals and groups in both countries were committed to the continuation of nuclear testing. Their influence eroded the ability of the two leaders to close the insignificant gap that separated them on the issue of the number of on-site inspections. The end result was the 1963 treaty that bans all but underground nuclear tests. From a health perspective, this treaty was an enormous achievement, but it did precious little to halt the weapons race. In fact, the U.S. Joint Chiefs of Staff insisted on a continuing underground testing program as a condition of their support for the partial ban.

In retrospect, the two leaders were forced to give up their efforts to halt nuclear weapons testing at a perfect moment for such an agreement. The technical situation was ideal because weapons on both sides were good enough for deterrence but totally inadequate for attacking and destroying each other's nuclear forces. In other words, it was a period of considerable stability. Since then, lightweight but powerful weapons and new guidance systems have increased the potency and lethality of the missile force on both sides. This has given rise to fears about the vulnerability of land-based systems and to designs of bizarre new systems like the MX. Few experts believe that another stage of escalation such as the MX will provide any additional security. On the contrary, it will increase the already too high overkill potential. What's more, new warheads are hardly required for such systems.

Despite the fact that 115 nations have adhered to the Non-Proliferation Treaty, several countries—Argentina, Brazil, India, Israel, Pakistan and South Africa, for example—commonly acknowledged to be "near nuclear," have refrained thus far. These nations fail to understand why they should not develop weapons if the two superpowers require ever more sophisticated ones. A comprehensive nuclear test ban is an essential and safe starting point for a new effort to halt the arms race.

This pact, so long advocated by the United Nations and so long an essential ingredient of an effective arms-limitation program, should be undertaken now. It would contribute to the security of both superpowers and would provide a positive step forward at a time when East-West relations are dangerously polarized.

JEROME B. WIESNER
President Emeritus and
Institute Professor, Massachusetts
Institute of Technology

APPENDIX 56

OCTOBER 1982 BULLETIN OF THE ATOMIC SCIENTISTS ARTICLES ENTITLED "BACKING AWAY FROM TEST BAN TREATIES" AND "SPECIOUS AGREEMENTS FOR THE ARMS RACE"

By attacking the verification regime of the Threshold Test Ban Treaty, the Administration has derailed further negotiations for a comprehensive test ban—an example of the vulnerability of arms control to political pressures and the volatility of public opinion.

JOEL S. WIT

Backing away from test ban treaties

After over a year of interagency deliberations, the Reagan Administration's test ban policy is beginning to take shape. In a National Security Council meeting on July 19 President Reagan decided, in effect, to discontinue the comprehensive test ban negotiations begun under President Carter. Instead, he decided to press the Soviets for improved verification provisions in the as yet unratified Threshold Test Ban Treaty, banning nuclear weapons tests over 150 kilotons, and the Peaceful Nuclear Explosions Treaty, banning all single peaceful nuclear explosions over the same level.

The Administration's decision to set aside the on-going negotiations should come as no surprise. The comprehensive test ban has been a declared goal of U.S. arms control policy since the 1950s. Yet from the time of the Limited Test Ban Treaty in 1963, only the Carter Administration has seriously pursued a total halt in nuclear testing. Moreover, there have been a number of signals from Reagan Administration officials that a comprehensive ban at this time would not be in the national interest. According to this viewpoint, plans for new weapons require testing, as does the need to assure continued reliability of the nuclear stockpile.

In any case, the comprehensive test ban is anathema to the national security establishment of the current regime. Some Administration officials, in their former incarnations as members of the Committee on the Present Danger, actively opposed the Carter initiative to the point of briefing then candidate Margaret Thatcher in early 1979 on the dangers of a comprehensive ban. Since Britain is a party to the talks, the object seems to have been to make the discussions even more difficult if she was elected.

The Administration's decision to insist on improved verification provisions in the Threshold Test Ban and the Peaceful Nuclear Explosions Treaties, while something of a surprise, should not have been totally unexpected. Although many believe the verification regimes of these agreements to be sound, they have proved to be particularly vulnerable to attack by opponents of test bans in general, and have caused great difficulties for both the Ford and Carter Administrations. This is especially true of the Threshold Test Ban Treaty. The 150-kiloton limit was not set to conform with U.S. seismic monitoring capabilities but rather to allow completion of on-going weapons programs.

The Atomic Energy Detection System can detect and identify explosions down to a much lower level but has had trouble pinpointing yields of large explosions. To help alleviate this problem, the Threshold Test Ban Treaty does provide for:

- a data exchange on the geological characteristics of each country's test sites and
- the exchange of information on specific tests to help calibrate monitoring systems.

Since both the Ford and Carter Administrations delayed ratification of the threshold test ban and its companion agreement, neither of these provisions has gone into effect.

Even without these special provisions, the margin of uncertainty in estimating yields has narrowed over the six-year period in which the superpowers have informally observed the 150-kiloton limit. Up until 1976 when the treaty went into effect, a number of intelligence analysts felt the yields of Soviet tests were being consistently overestimated. The U.S. methodology was based on the questionable assumption that the geology at the Soviet test sites was similar to the Nevada test site. As a result, seismic signals generated by Soviet detonations were compared to similar signals generated by U.S. tests and an estimate was produced. In contrast, the British technique produced, in many cases, much lower results which many in the intelligence community thought to be more accurate. However, efforts to refine the old U.S. method were blocked by the Pentagon and the Defense Advanced Research Projects Agency, which is responsible for Project Vela, the main government seismic research program.

By the end of 1976 it had become obvious that this situation was no longer tolerable, given the new premium placed on having accurate estimates by the Threshold Test Ban Treaty. A Soviet high yield test series, beginning on July 4, had produced estimates hardly acceptable for the verification of an arms control agreement. The results were promptly leaked to the press as proof that the Soviets had violated the agreement and therefore could not be trusted. The new Carter Administration was confronted almost immediately with the problems posed by verification, although with an interesting twist. In March 1977, the White House, at the urging of the Department of State,

A decision to scrap all of the test bans could have united the Congress and public opinion against the President. The Administration's new policy is not likely to have that effect.

postponed a high-yield nuclear test, code named Marsilly, which was to occur during Secretary of State Cyrus Vance's crucial trip to Moscow. Assuming Soviet monitoring capabilities were no better than ours, U.S. officials felt the detonation might provoke potentially embarrassing Soviet inquiries.

In the spring of 1977, after a prolonged debate in the intelligence community also involving consultations with the British, a special panel was formed by Frank Press, President Carter's Science Advisor and an eminent seismologist. Its purpose was to examine U.S. estimating techniques as well as alleged Threshold Test Ban Treaty violations. The panel concluded, with the support of an overwhelming majority of the seismic intelligence community, that U.S. methodology should include a correction for the difference in seismic wave attenuation between U.S. and Soviet test sites. Even with the revision, estimates could still have an uncertainty factor of 2. Using the bias correction, the 1976 Soviet tests, particularly the July 4 blast which had caused the most concern, now appeared consistent with the 150-kiloton threshold.

However, the degree of uncertainty still remained sufficiently large to plague the Carter Administration. As SALT II went to the Hill for ratification in the summer of 1979, the Soviets detonated two high yield explosions which, even given the revised methodology, could have been construed as violations of the Threshold Test Ban Treaty. Once again, the information leaked to the press. Once again, consultations were held with the British both in London and Washington. Based on their estimates, the British had come to the conclusion that the Soviets probably had not exceeded the 150-kiloton threshold. Nevertheless, the timing of the blasts and their potential impact on SALT ratification caused a great deal of concern at the highest levels of the Administration. The issue was discussed at more than one Vance-Brown-Brzezinski meeting.

Whether the existing treaty provisions are adequate to solve the verification problems is open to debate. The key to this question seems to be the data exchange, and the existing exchange might not be sufficient. This opinion is held not just by those who could be expected to oppose test bans but others in the government technical community as well. Moreover, some analysts have also raised the possibility that the Soviets could deliberately provide incorrect data although, since the United States already possesses unspecified geological information on the Soviet sites, this could prove to be a risky enterprise. In response to alleged violations in the summer of 1979, the Carter Administration pressed the Soviets to agree to the installation of a U.S. seismic station in the Soviet Union. This would have provided more information than the treaty data exchange. This information would have been foolproof and could not have been falsified. The Reagan Administration might decide to make the same proposal or to ask the Soviets for prior notification of tests so U.S. personnel could be allowed into the area to set up a local seismic network.

A simpler, less troublesome option is available. Almost all the questioned Soviet detonations have occurred in a specific area of the Semipalatinsk test site. It is believed that the deep geological formations in that region make yield estimation extremely difficult. Therefore, rather than pressing the Soviets for intrusive measures they might not be willing to accept, the United States might ask them to forego testing in that test site. In any case, the United States should also intensify its own efforts, perhaps with the assistance of the British, to fine tune its yield measuring techniques.

How the Soviets will react to the Administration's policy is as yet unknown. They too might have some incentive to strengthen the verification regime. Soviet monitoring capabilities are certainly no better than those of the United States. More accurate estimates of U.S. test yields could prove useful to them in gauging the counterforce potential of new U.S. nuclear weapons. However, the prognosis for meaningful discussion is not good. In the first official reaction to the new test ban policy, *Tass* predictably dismissed the Administration's verification concerns as a sham.

Certainly, the Soviets have good reason for being unhappy. In spite of continual representations by the Soviet Union, the United States still has not ratified either the Threshold Test Ban Treaty or the Peaceful Nuclear Explosions Treaty. Moreover, if past experience is any guide, the Soviets are not likely to prove receptive either to the implication that they have violated the 150-kiloton threshold or to the U.S. demand for stiffer verification provisions. The Soviets reacted strongly when the Carter Administration attempted to get more data. After all, the United States had not even ratified the existing agreements to get the Threshold Treaty data exchange and was asking, in the context of a non-ratified treaty, for even more intrusive information.

Above all, one must wonder whether the Reagan Administration is interested in serious discussions. Outright U.S. rejection of the comprehensive, the threshold and the peaceful explosions treaties, which has been advocated by some officials in the Departments of Energy and Defense, could have created political problems for the President. Seizing on the threshold's verification inadequacies could enable the Administration to maneu-

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He is conducting a project on comprehensive test ban policy in the Carter Administration, from which information for this article was drawn.

ver itself into a position where no substantive progress will have to be made. The emphasis on the need for better verification plus at least a *prima facie* case that there are problems in monitoring the 150-kiloton threshold is likely to find some resonance in the domestic arena. After all, while Americans have become more vocal arms control supporters, that support rapidly evaporates if it is perceived the Soviets can violate an agreement with impunity.

Moreover, it is almost certain that the Administration has factored possible Soviet reactions into its calculations. If the Soviet Union rejects eventual U.S. overtures to begin discussions, the Administration will have the necessary excuse not to pursue test bans of any kind. Already, Administration officials have made the link between improving verification of the 150-kiloton threshold and achieving an effective verification regime for a comprehensive test ban. This argument, used by test ban opponents during the Carter Administration, is specious since verifying the total absence of testing is different from pinpointing the yields of large Soviet detonations. If the Soviets, for some reason, agree to discussions, progress is unlikely, given the nature of the issues involved and the relative lack of political pressure being felt in other negotiations such as the Intermediate Nuclear Force talks.

Whether this strategy will prove successful is still uncertain. In devising stiffer verification proposals, the Administration could face some tough bureaucratic infighting. While the Joint Chiefs of Staff and the Department of Energy are the first to emphasize the importance of having airtight verification, they are also the first to express consternation at the possibility that intrusive measures will have to be reciprocal.

Politically, while the almost instantaneous leak of the President's decision to the New York Times has put the Administration on the defensive, it might yet succeed in weathering the storm. A decision to scrap all of the test bans could have united the Congress and public opinion against the President. The Administration's new policy is not likely to have that effect. It has split the legislative branch. Senator Charles H. Percy of Illinois, chairman of the Foreign Relations Committee and a supporter of the threshold arrangement, was "pleased" that the President had not decided to reject the treaties entirely. Others, led by Edward M. Kennedy of Massachusetts, plan to introduce a resolution calling on the President to "request Senate consent to ratifiction of the TTBT [Threshold Test Ban Treaty] and PNET [Peaceful Nuclear Explosions Treaty] and to resume negotiations towards a comprehensive test ban as soon as possible." Public reaction is as yet uncertain but Administration statements that it plans to continue emphasis on reducing existing nuclear weapons are probably designed to further offset any negative impact.

Even more important than the Reagan Administration's test ban policy are its implications for the future of arms control. Verification is based not only on technical monitoring capabilities but also on political acceptability. Since the mid-1970s, arms control agreements in general and, more specifically, their verification provisions have come under increasing political attack. This pressure, combined with a growing public desire to achieve "meaningful" agreements technically more difficult to monitor, aside from creating new stresses in reaching agreements with the Soviet Union, could also create new opportunities for domestic opponents to derail arms control initiatives.

In this context, the fate of the threshold test ban is an early warning sign of what can happen to agreements in a politically demanding environment. Either greater public understanding of monitoring arms control treaties must be fostered or verification requirements driven by political pressures could become so intensive as to rule out achieving meaningful agreements. ☐

GEORGE W. BRESLAUER

Specious arguments for the arms race

> *"God knows, it's been frustrating to read some of these stories and not be able to say, 'That's untrue! Here's what the actual facts are. . . .' It's just been frustrating the hell out of me."*
>
> —*Cyrus Vance*[1]

In recent years, we have heard a great deal about how detente was a one-way street, how the Soviets used arms control for unilateral advantage, and how U.S. security would be better enhanced by a strategic buildup than by arms control. Some of these arguments are accompanied by heavy documentation regarding Soviet capabilities, intentions and past behavior. Others are based primarily on assumptions or contentions about the psychology of deterrence and the logic of bargaining.

If the Strategic Arms Reduction Talks (START) and Theater Nuclear Force negotiations now under way prove fruitless, all these arguments will again be voiced, at still higher vol-

APPENDIX 57

MARCH 1983 BULLETIN OF THE ATOMIC SCIENTISTS ARTICLES ENTITLED "NO EVIDENCE OF CHEATING" AND "SEISMIC VERIFICATION"

GERALD E. MARSH

No evidence of cheating

In his August 10, 1982 column titled "Test Ban Folly," Jack Anderson reported that President Reagan had "decided, at a recent National Security Council meeting, that he didn't want to resume talks with the Soviet Union and the British on a comprehensive nuclear test ban." Anderson claimed that the reason for this decision was that "secret documents and intelligence sources" disclose that the United States does not have "adequate means to catch the Russians in violations of a test ban." Citing the unratified Threshold Test Ban Treaty as an example, Anderson claimed that these secret documents showed that "the Russians appear to have exceeded the 150-kiloton limit at least 11 times since 1978." This interpretation of the information contained in the secret documents is apparently in error. There are undoubtedly two documents at issue, both written by Warren Heckrotte and Peter H. Moulthrop of Lawrence Livermore Laboratory. At least one of these had a very wide distribution in the nuclear weapons community. Of principal interest is UCID-19352, titled "An Analysis Based on Seismic Data of the Pattern of Soviet High-Yield Nuclear Tests from March 31, 1976 through December 31, 1981." This document is classified SECRET/NSI: secret because it contains national security information, and is therefore not publicly available.

The conclusions reached in these papers have, however, recently been made public. Michael M. May, associate director at large at Livermore, referring to an earlier question on the subject, said that the documents "did conclude that there was no evidence that the Soviets had cheated on the Threshold Test Ban Treaty."

Warren Heckrotte has summarized the conclusions of his two papers as follows:

> "The distribution of seismically measured yields of Soviet nuclear weapons tests is not inconsistent with Soviet observance of the 150 [kiloton] limit. However, the distribution is also not inconsistent with a distribution of actual yields in which there are some events above 150 [kilotons]. This reflects the statistical nature of the problem."

Heckrotte is making the point that although the "tail" of the yield distribution may extend beyond the 150-kiloton limit, this does not necessarily imply the Soviets have cheated.

If Jack Anderson is correct about the process leading to President Reagan's decision not to resume negotiations on a Comprehensive Test Ban, this important treaty may have fallen victim to a misunderstanding of the statistical nature of seismic measurements.

In the accompanying article, John Wilke gives us a valuable and important perspective on the seismic verification issue. He addresses not only the question of coupling or calibration factors relating weapon yield to seismic magnitude, but also the political dimension of the problem. What he does not say, but what is clearly implicit in his article, is that the Soviets have very little—if anything—to gain by violation of either the Threshold Test Ban or a Comprehensive Test Ban, but much to lose. ☐

Gerald Marsh, physicist working at the IIT Research Institute, Chicago, Illinois 60616, is co-author of Born Secret: The H-bomb, the *Progressive* Case and National Security *(1981).*

JOHN WILKE

Seismic verification

The Pentagon currently plans to design and produce some 17,000 new nuclear weapons over the next six years. To this end, President Reagan in 1982 authorized stepped-up nuclear testing and withdrew the United States from further participation in tripartite test-ban talks with Britain and the Soviet Union. Administration officials spoke of the need to test new warhead designs, and some suggested that the United States might not continue to abide by the terms of the existing Threshold Test Ban Treaty, which limits underground nuclear tests to an explosive yield of less than 150 kilotons.

In the United Nations, former U.S. Arms Control and Disarmament Agency chief Eugene V. Rostow declared, "We do not believe that, under present circumstances, a nuclear test ban could help reduce the threat of war."

The U.S. delegation later cast a series of negative votes on test-ban resolutions that were supported by an overwhelming majority of nations. These included measures sponsored by the Soviet Union, Canada, Japan, Mexico, Australia and many others, calling for a halt to all nuclear testing as a first step to slow the arms race. And the United States stood alone in opposition to a resolution calling for an international seismic monitoring system to verify compliance with a comprehensive test-ban treaty.

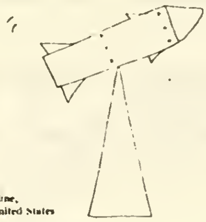
Explaining their opposition to nuclear test-ban negotiations, Administration officials cited suspected Soviet violations of the threshold treaty, adding that seismic technology was inadequate to verify compliance.

But scientists outside the defense establishment have challenged the Administration's doubts about verification, suggesting that—intentionally or not—the Defense Department had misinterpreted the seismic data that led them to conclude that there had been Soviet treaty violations.

Reporting their research on the question of treaty verification, two leading U.S. geophysicists, Lynn Sykes of Columbia University and Jack F. Evernden of the U.S. Geological Survey's Center for Earthquake Research, are unequivocal: "We have not found a single instance in which the size of a Soviet test has exceeded the threshold."

They wrote in *Scientific American* that the Administration's accusations "are based on a miscalibration of one of the curves that relates measured seismic magnitude to explosive yield. When the correct calibration is employed, it is apparent that none of the tests exceeded 150 kilotons, though several came close to it."

Sykes and Evernden say that modern seismic science could police a test-ban treaty, even if efforts were made to mask the geophysical effects of explosions. And if unmanned, tamper-proof seismic stations were permitted within the borders of both nations—a principle agreed to by the Soviets in 1980—nuclear detonations as small as one kiloton could be detected.



Cline,
United States

Sykes has conducted extensive research for the Defense Department's Office of Underground Test Detection, and was a member of the U.S. delegation that concluded the threshold treaty in Moscow in 1974. In an interview, he said he has reviewed classified records of those Soviet tests that were thought to have exceeded the threshold, and—while declining to discuss the data—he emphasized that it had not altered his conclusion that the Soviets are still complying with the 150-kiloton limit. Further, according to Sykes:

> "The Defense Department has in the past ten years shifted funding for verification research away from the several universities that have long been involved, where the best work was being carried out. More recently, Defense has contracted with individual consulting firms, since most of us in the academic community believe the [verification] problem essentially solved."

Sykes worked with the Air Force from 1974 through 1977 on seismic assessment of underground explosions (tests in all other environments were banned by the Limited Test Ban Treaty in 1963), and over the years his laboratory received grants for test detection research from the Pentagon.

In 1980, the grants ended. And while funds for verification research have been cut, money for operations at the Nevada nuclear test site has more than doubled since President Reagan took office, rising to $354 million this year. The number of nuclear tests also has increased. In the mid-1970s their frequency had leveled off to between 10 and 12 each year, from a high of 40 in 1966.

Under the present Administration, however, the number increased to 14 in 1980, 16 in 1981, and 19 announced in 1982. And last August, the Pentagon chose to commemorate the Hiroshima and Nagasaki bombings with a widely-publicized nuclear test during which then-Secretary of Energy James Edwards confirmed the Administration's intent to continue detonating nuclear bombs. (The test marked another—and different—anniversary: On August 5, 1963, President Kennedy had signed the Limited Test Ban Treaty.) Edwards also refused to rule out U.S. abrogation of the threshold treaty, still unratified by the Senate and under increasing attack from within the Reagan ranks.

On the Soviet side, nuclear tests have dramatically slowed in recent years, according to James Cannon, an analyst with the U.S. Department of Energy. He told the journal *Science* that Soviet tests had dropped from 20 in 1978 to 10 in 1980, to nine in 1981, and—at last count—to only four in 1982.

Soviet First Secretary Yuri Andropov rejects the Reagan Administration's contention that the Soviets hold an edge in overkill capacity, and has left standing the Brezhnev proposal calling for a complete testing moratorium followed by renewed comprehensive test-ban negotiations. But the Pentagon apparently has little interest in pursuing this course. ☐

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APPENDIX 58

MARCH 1985 BULLETIN OF THE ATOMIC SCIENTISTS ARTICLE ENTITLED "POLITICS, TECHNOLOGY, AND THE TEST BAN"

Politics, technology, and the test ban

Seismologists have met all the technical problems of verifying a comprehensive test ban. Now it is clear that political considerations have stood in the way of such a treaty all along, and verification problems have been used as an excuse.

by Jack F. Evernden

POLITICAL CONCERNS for many years have been the ruling consideration in negotiating test ban treaties, even though many have claimed technical considerations to be paramount. In fact, the technical problems have been basically solved by seismology under a long-standing national program to achieve the capability to detect and identify underground explosions and to estimate their yields.

A small segment of seismology has gained such importance that presidents, secretaries of state, premiers, foreign ministers, and ambassadors hold forth eloquently on their understandings or misunderstandings of the subject. These politically motivated assertions, however, have little to do with the relevant science. What is frightening is that national policy has been based on whether seismologists can or cannot identify the seismic waves of earthquakes and explosions at some arbitrarily selected small magnitude level, rather than on the enormity of the potential catastrophe if nuclear weaponry is not contained.

Even if we once believed that technical considerations were of ruling importance in attaining a comprehensive or a low-threshold test ban, that belief is no longer tenable. Technical understanding of the seismological aspects of monitoring such treaties is now essentially complete, and we know that a low-threshold treaty can be successfully monitored. This knowledge extends to detection of the seismic signals of explosions, to identification of those signals as the product of underground explosions rather than earthquakes, and to establishment of the yield of the explosion within factors of certainty relevant to meaningful monitoring. What is more, there is every indication that the required monitoring network could be established and maintained within parameters acceptable to the Soviet Union.

L.R. Sykes and I published, in 1982, a detailed discussion that covers the range of techniques used to identify a seismic source, based upon location, depth of focus, and the spectral composition of the elastic energy radiated from it.[1] Refinement of these techniques in recent years has disposed of lingering concerns over the possibility of "decoupling," or muffling, explosions by setting them off in large cavities, as well as the possibility of "hiding" an explosion in the reverberations of a distant earthquake.

An elastic body like the earth supports two types of seismic waves propagating throughout its body as well as two types propagating over its surface. Three of the four types of waves are present in a simple explosion; all four are generated by earthquakes and most explosions. However, major differences in the radiated waves of each type persist. The patterns of waves radiated by an explosion are radially symmetric, while earthquake patterns are much more asymmetric than those of nearly all explosions, earthquake asymmetry being associated with the movement of two sides of a fault along which strain is released. More importantly, the relative levels of the different types of waves and their amplitude in relation to frequency are predictable and easily observed functions of the type of seismic activity.

Shifting the monitoring network's attention to higher fre-

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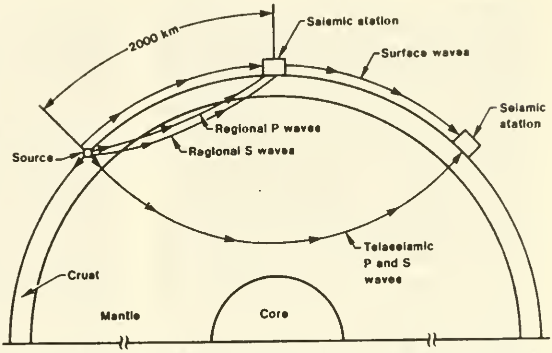

An event such as an earthquake or an underground nuclear explosion generates seismic waves that propagate through the earth. At teleseismic distances (more than 2,000 kilometers) the waves of interest are of two types: body waves, which travel through the earth, and surface waves, which propagate along the surface. There are two main kinds of body wave: the P or compressional wave and the S or shear wave. One type of surface wave is called a Rayleigh wave. Body-wave magnitude is determined by measuring the amplitude of the P wave at 1 Hertz, and surface-wave magnitude by measuring the amplitude of the Rayleigh wave at 0.05 Hertz. The ratio of these two magnitudes is used to distinguished between earthquakes and explosions.

Because the proposed seismic monitoring stations will be located within the country they monitor, many of them will be at regional distances (less than 2,000 kilometers). Regional seismic signals travel mainly in the upper mantle and crust of the earth (not shown to scale in the figure) rather than through the deep mantle. Receivers at regional distances can detect both body and surface waves propagated through the crust. Because of shearing that occurs along its fault plane, an earthquake generates a significant amount of S-wave and surface-wave energy. In contrast, an explosion, which produces little shear energy, is a poor generator of surface waves. The ratio of body-wave magnitude to surface-wave magnitude is lower for an earthquake than for an explosion of similar magnitude. Because of their different propagation paths, regional signals include more high-frequency components than do teleseismic signals. As an explosion radiates higher seismic frequencies than an earthquake, the ratio for P-wave spectral amplitudes at different frequencies can also be used to discriminate the two source types. *(Courtesy Lawrence Livermore National Laboratory)*

quency levels than originally proposed has solved a number of problems. Since the decoupling (muffling) effect decreases at high frequencies, monitoring these frequencies makes it possible to detect even low-yield, fully decoupled nuclear explosions. The differences between earthquake and explosion wave patterns at high frequencies also make it possible to distinguish between those two events even if they are recorded simultaneously. This totally eliminates the possibility of hiding the seismic waves of a nuclear explosion in those of an earthquake.

Two questions about the use of these discriminants need to be asked. First, their effective use to detect and distinguish small-magnitude explosions and earthquakes requires detection of frequencies of as high as 30 hertz at distances of a few hundred kilometers. Do the critical waves propagate to such distances in terrains found in most of the Soviet Union? Data available for regions geophysically analogous to most of the Soviet Union, such as the eastern United States, demonstrate that they do. The other question is whether such waves are detectable in the presence of ambient levels of microseismic, high-frequency background noise. Again, the answer is affirmative.

THE ROUTE TO our present verification capability has had some tragic twists and turns. In the late 1950s seismologists proposed criteria for discriminating between nuclear explosions and earthquakes, based on the absence of one of the four wave types in the explosion patterns. The demonstration that some earthquake-associated wave patterns were indeed detectable in some nuclear explosions cast doubt on the verification capability, and President Kennedy was persuaded to drop his insistence on a comprehensive test ban.

Unfortunately, seismologists failed to garner the obvious explanation from the available data: that explosions set off in earth formations where some strain is already present may trigger minor earthquakes, with all the associated wave patterns. Data adequate to demonstrate the validity of the criteria currently used for identifying underground nuclear explosions were available before Kennedy's decision. In fact, the first demonstrations of the validity of most of these criteria, though taking place after ratification of the Limited Test-Ban Treaty of 1963, were based upon data which predated that agreement. Scientific neglect must be blamed in this case for denying the world the one and only real chance it has yet had for negotiation of a treaty banning all nuclear explosions.

Has there ever been support for a comprehensive test ban within the U.S. government since the Kennedy presidency? During the last two decades of nearly continuous negotiations on such a ban by the multinational Committee on Disarmament in Geneva, both political and technical personnel in the U.S. delegations have understood that the intent of our participation was to thwart any progress on a comprehensive test ban by that Committee. Chairman Lewis Strauss of the Atomic Energy Commission protested a test cessation as a "very fateful step."[2] Recent testimony before the Subcommittee on Intelligence and Military Application of Nuclear Energy of the House Armed Services Committee expressed concern over "stockpile aging" and "modification of warheads for new military requirements," as well as the potential attrition of skilled designers that cessation of testing would bring about.[3]

In the mid-1960s, while employed by the Department of Defense, I was asked to advise on the technical content of a letter, written for the signatures of the Joint Chiefs of Staff, withdrawing their previous support for a verifiable comprehensive test ban. It had just been convincingly demonstrated for the first time that there were indeed seismological techniques that could distinguish between the seismic waves of explosions and those of earthquakes, and that there was every reason to believe that these techniques would work for smaller events than had yet been investigated. The Chiefs, obviously, had been willing to support a treaty as long as it was thought that seismologists would be incapable of monitoring it. When that shield was removed, the truth was revealed: that they were then, and would remain, opposed to a comprehensive test ban.

Over the years, each advance in seismological verification has been deprecated by those high in the U.S. government. The Defense Department did not dispute testimony in the early 1970s that a network fundamentally acceptable to the Soviets could be built to monitor Soviet explosions as small as one kiloton. Instead, the director of Defense Research and Engineering insisted that monitoring to a quarter of a kiloton would be required for national security.

A rational answer to the question of how low a threshold monitoring capability is required should be constrained by these considerations:

- Development of strategic nuclear weapons requires tests in the five-to-ten kiloton range.
- The specified level must not create an unbalanced risk for the parties of the treaty.
- The specified level must be enforceable but must not create the basis for interminable irrelevant arguments.

The first condition would be met by a network of about 25 stations within the Soviet Union, plus 15 or so surrounding that country, and a complementary network within the United States. Such a network could easily monitor a treaty within a one-kiloton limit—well below the levels required for the development of strategic weapons.

Secondly, weapons laboratories are concerned that signing an unenforceable comprehensive test ban treaty could create an unbalanced risk, as in the following scenario: we observe the letter of the treaty and allow our key personnel to drift away to stimulating research in other fields, while our determined adversaries keep their laboratories going by conducting low-yield tests, below the detection threshold of the monitoring network. After the treaty has been in force for, say, 10 years, the Soviets abrogate the treaty on some pretext and resume the arms race with a great advantage in weapons design.

With respect to the third condition, seismologists know of no certain way to distinguish the seismic waves of a several-ton tamped (placed in solid rock) explosion from those of a low-yield, fully decoupled nuclear explosion. Thus, even given a capability to detect and identify as an explosion the signal of a sub-kiloton decoupled explosion, one could not distinguish it from the plethora of small industrial explosions taking place frequently within the Soviet Union. Placement of the treaty threshold too far below that required for security purposes would only lead to endless confrontation over irrelevancies.

ALL OF THESE considerations suggest that a low-threshold treaty, establishing a one-kiloton level, would be preferable to an outright ban on all testing. The difference between this level and the five-to-ten kiloton testing required for weapons development is so great that any confusion about a yield near the threshold would not come close to jeopardizing national security. In the other direction, a fully decoupled one-kiloton explosion generates a signal comparable to that of a five-ton tamped explosion. Most industrial explosions are below this level, and those above it are generally distributed charges designed to break and move rock. The monitoring network could identify most of these, although an occasional Standing Consultative Commission meeting would be required to clarify particular events. Finally, with such a level of testing permitted, all parties could maintain the integrity of their laboratories.

It would seem advisable to include provisions in the treaty which restrict low-yield tests to a single site, and forbid decoupled explosions. These provisions would not guarantee compliance but would greatly decrease the scope for dispute on technical matters.

If it is true, as Noel Gayler and others have repeatedly claimed, that there is no potential military use for theater nuclear weapons, which use low-yield warheads, a one-kiloton threshold treaty would effectively constitute a comprehensive test ban.

The U.S. government has long insisted that on-site inspections be part of a comprehensive test ban treaty. By the time the early round of negotiations, begun under Eisenhower, ended during the Kennedy years, the Soviets had agreed to three annual inspections. But the United States was adamant that seven were necessary. During the most recent round of talks, which began and ended during the Carter Administration, the United States, the Soviet Union, and the United Kingdom agreed in principle to a type of on-site inspection different from the mandatory ones previously discussed. According to the trilateral report submitted in 1980 to the Committee on Disarmament in Geneva, in the event of a seismic disturbance of questionable origin in one of the three countries, the other party could "challenge" the source of the disturbance and request an inspection. By providing detailed arguments about why an inspection was necessary, the challenging side could not easily be refused.

Yet while negotiators shifted the terms of on-site inspections, seismologists also had learned how to do the monitoring in a manner acceptable to the Soviets. Moreover, it was demonstrated in elaborate Defense Department testimony to Congress in the early 1970s, that there is no way to obtain useful information through on-site inspections even if the Soviets agreed to them. It should be noted that the Soviet refusal to accept on-site inspections is at least as irrational as the U.S. insistence on them. One cannot help but speculate that if the Soviets ever agreed to them, on-site inspections would never be heard of again.

The Reagan Administration has tried harder than any other to convince the American public of the dangers of arms control treaties and of Soviet misbehavior. However, since the invention of the bomb, nearly all U.S. administrations, Democratic or Republican, have consistently cast serious doubt on the verifiability of a comprehensive test ban treaty, even while asserting support for such an agreement. Only after leaving office did President Eisenhower realize, and declare, that his greatest mistake was in failing to negotiate a comprehensive test ban.

The Carter Administration, after obtaining Soviet agreement to a remarkable treaty draft during the trilateral discussions in Geneva, aborted further measures to complete an accord. Administration officials were afraid that under a test ban something might go wrong and give the Soviets an unspecifiable but critical advantage. Carter, according to Harold Agnew, then director of Los Alamos National Laboratory, had every intention of going ahead with a ban until Agnew and Roger Batzel, at that time head of Livermore National Laboratory, spent a mere two hours talking with him and "turned him around."[4]

It is now clear that nearly all men in positions of responsibility will build yet another generation of nuclear warheads rather than make any move toward nuclear restraint. As Richard Garwin puts it, "Time after time our national security choices have been misdirected by false argument, concealed assumptions and hidden agendas, and . . . some of the best options have been ruthlessly suppressed."[5]

There is no technical obstacle to negotiation of a verifiable test ban treaty. But the implementation of a rational solution to a political problem is vastly more difficult than finding that solution. If we are to save ourselves, we and the Soviets must learn that our differences arise out of mutual fear and mutual isolation, out of historical processes which have so colored and warped the perceptions of all of us that we accept utter nonsense as revealed truth. For the sake of ourselves and our children, we must strive to approach each other through accommodation and understanding rather than through confrontation and misunderstanding. ☐

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1. L.R. Sykes and J.F. Evernden, "The Verification of a Comprehensive Nuclear Test Ban," *Scientific American* (Oct. 1982), pp. 47–55. See also L. Sykes, J. Evernden, and Ines Cifuentes, "Seismic Methods for Verifying Nuclear Test Bans," in D.W. Hafemeister and D. Schroeer, *Physics, Technology and the Nuclear Arms Race* (New York: American Institute of Physics, 1983); J.F. Evernden and C.B. Archambeau, "Seismic Discrimination of Earthquakes and Explosions," in *Technical Means of Verification* (Elmsford, New York: Pergamon, 1985).
2. A. Greb and W. Heckrotte, "The Long History: The Test Ban Debate," *Bulletin* (Aug.-Sept. 1983), p. 37.
3. Ibid., p. 40.
4. Interview with Harold Agnew, *Los Alamos Science Magazine* (Summer-Fall 1981), p. 154.
5. R. Garwin, "Who Proposes, Who Disposes, Who Pays?" *Bulletin* (June-July 1983), p. 11.

APPENDIX 59

April 1984 Bulletin of the Atomic Scientists Article Entitled "Stockpile Reliability and Nuclear Testing" [1]

(By Hugh E. DeWitt and Gerald E. Marsh)

After the Soviet Union agreed to cancel its program of peaceful nuclear explosions in 1977, President Carter instructed U.S. negotiators to seek a five-year comprehensive test ban treaty. In reaction, Secretary of Energy James Schlesinger, Director Roger Batzel of Lawrence Livermore Laboratory and Director Harold Agnew of Los Alamos Laboratory reportedly spent an hour and a half attempting to dissuade the President from this course.

A key opposition argument was that without nuclear testing, confidence could not be maintained in the existing U.S. stockpile of nuclear weapons. The weapon laboratories' arguments are contained in a series of letters published in Appendix 3 of the House Armed Services Committee Report No. 95-89, "Effects of a Comprehensive Test Ban Treaty on United States National Security Interests."

This appendix also contains the now well-known letter to President Carter from Norris Bradbury, former director of Los Alamos; J. Carson Mark, head of Los Alamos' Theoretical Division from 1947 to 1973; and Richard Garwin, a long-time consultant to various government agencies and laboratories on nuclear weapons matters. The letter takes the position that the viability of the stockpile can indeed be assured under a comprehensive test ban treaty.

An exchange dealing with this question recenty occurred between Roger Batzel and Richard Garwin. The discussion took place during the International Seminar on How to Avoid Nuclear War in Erice-Trapani, Sicily, on August 20, 1983.

Batzel. Yes, I wanted to take a little issue with Dick [Garwin] on the issue of the CTBT (comprehensive test ban treaty). We've had a difference of opinion there, and since I'm the Director of one of the two nuclear weapons research and development laboratories in the United States, I am asked and provide my view of that situation with respect to the need for nuclear weapons tests in order to provide a viable nuclear weapons stockpile. My position is . . . that I do not know of a way of providing a viable nuclear weapons capability for the United States without nuclear weapons tests. . . .

Garwin. Let me go into a little more detail on that question. I presume Dr. Batzel and I are both talking about continuing the existing nuclear weapons (or some set of them) in the stockpile, rather than putting in new designs, or modified, or product-improved designs. Right?

Batziel. Right.

Garwin. And so the question is, can we identify this particular weapon (a Mark 48 or something like that) and continue to guarantee year by year, that it will work? I believe we can. Let me tell you what is done in the United States and I presume in every country that has nuclear weapons stockpiled. Nuclear weapons have a number of elements; they have a ballistic case; they have a firing and fusing set; they have some high explosive or the equivalent and then they have the specific nuclear components (the plutonium or the uranium-235 or whatever). There is absolutely no ban on the destructive testing (that is the actual dropping), firing and so on, if all of this equipment except for the nuclear components, and one can make all kinds of measurements in the laboratory to make sure that every testable part of the system is working as it used to work.

One has to do this kind of experiment before one puts a weapon into the stockpile. You don't fire it very many times to obtain a nuclear yield before you put it into the stockpile. So you have to be quite sure that the fact that it worked once or twice is representative of the fact that it's going to work every time it is called upon. And so we have a program whereby we disassemble weapons routinely. We fire their different parts; if they don't work or if they are out of specification—time delay, uncertainty, or whatever—we take corrective action. We remanufacture. Now we may find that something does not have the design life. It rusts, corrodes, whatever, and we say, "How could we have been so stupid as to have made that mistake? Let's replace it with something better." *The answer is "No!" You don't replace it with something better. You build it just the same way you built it before, but you go back and you replace that part and remanufacture it every two years at considerably higher maintenance costs than you would like* [emphasis added]. Now when we have addressed this matter in congressional testimony, letters to the President, and so on, it comes down to the following point. Who is going to make the distinction between an allowable change because it is such a small change and something which, when combined over the years with all the other permissible changes, is going to make the weapon not work? The answer is, "People who understand about nuclear weapons."

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Then some say that we won't have anybody who understands about nuclear weapons unless we can fire nuclear weapons and get nuclear yields, because all the good people will leave the weapons laboratories. In the United States (not in the Soviet Union because "in the Soviet Union—although they won't know about nuclear weapons either—you can keep the good people in the weapons laboratories because the Soviet Union just assigns people to jobs and doesn't depend upon free will".) Let me give my concluding remark (which I am sure will not convince Dr. Batzel) and it is to go back in history to the director of the other weapons laboratory—the Los Alamos National Laboratory. Harold Agnew, as former director there, for some years maintained in his testimony that he did not have to have nuclear explosions (to ensure stockpile reliability). He said that what he *did* need was exemption from certain regulatory requirements—the Occupational Safety and Health Act in the United States (and there is a provision in that Act for national security exemption) and he would have to be given enough money to carry on an extensive non-nuclear testing series. Dr. Agnew no longer maintains that position, but he says, with Dr. Batzel, that he could not guarantee stockpile reliability without nuclear testing.

Dr. Agnew and I have explored (for hours at a time) why he has changed his position, and I believe that Dr. Agnew argues that he could not realistically expect support for non-nuclear testing without a nuclear weapons explosion program. I say that's a matter for political decision and that the technical people ought to confine themselves to saying what is required technically; and if the leaders of the country don't want nuclear weapons, or don't want reliable nuclear weapons, then they ought to be allowed to make that decision.

Now you all know as much as I know about this. We have been over also very specific problems in the past; my look at those problems continues to persuade me that we don't need nuclear testing for stockpile reliability, and Dr. Batzel's look at those problems persuades him that we do. Is that a fair statement?

BATZEL. Yes, it is fair.

If dependable nuclear weapons can be remanufactured without design changes and without further testing, then the reliability of the U.S. stockpile can be assured under a comprehensive test ban treaty. On this very important point, two weapons experts disagree. Batzel simply states that further testng is necessary while Garwin gives his reasons for believing further testing is not necessary. If indeed further testing of proven nuclear weapon designs is required for stockpile maintenance, then it is the responsibility of the weapons laboratories to put forward a convincing case.

If Batzel proves correct, then the weapons laboratories have produced weapon designs that seem to preclude the U.S. from signing a comprehensive treaty. This is contrary to stated U.S. policy goals for the last 20 year. Under the Limited Test Ban Treaty of 1963, the "original parties" agree that their intent is "to achieve the discontinuance of all test explosions of nuclear weapons for all time . . . [and] to continue negotiations to this end."

Article VI of the Non-Proliferation Treaty of 1968 states that "Each of the parties to the Treaty undertakes to pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race." The Arms Control and Disarmament Agency, in reference to this section of the Non-Proliferation Treaty, has noted that a comprehensive test ban treaty "is viewed by many non-nuclear-weapon states as a sine qua non for preventing the emergence of additional nuclear-weapon states and for preserving the NPT regime." In a world in which many foresee the need for defenses not only against the Soviet Union but also against dozens of governments armed with nuclear weapons, we can ill afford to waste the leverage which we would obtain in non-proliferation.

APPENDIX 60

ARTICLE FROM JULY 4, 1978, WASHINGTON POST ENTITLED "THE CASE FOR THE TEST BAN" [1]

(By Sidney D. Drell)

George Will's June 4 column "The Test Ban Quest" repeats misconceptions that we frequently hear about the comprehensive test-ban treaty (CTB) now under negotiation between the United States, the Soviet Union and Great Britain. Will's column alleges that "a full test ban would be unverifiable; it would prevent the United States from conducting appropriate tests to confirm the continued reliability of nuclear-weapons stockpiles; and it would jeopardize the U.S. ability to maintain its competence in nuclear-weapons technology." Those are serious misconceptions about the risks and consequences of a CTB that can readily be corrected.

Let me start with the fundamental issue of verifying a CTB. Critics such as George Will seriously underestimate our technical ability to monitor Soviet compliance. Not only have our seismic capabilities improved substantially in recent years, but also, if news reports are correct, we are pressing for the installation of highly sophisticated tamper-proof seismic stations in the Soviet Union. With such stations we could monitor with confidence events equivalent to a fraction of a kiloton. The stations would be in addition to the onsite inspection procedures that are also reportedly under negotiation.

Furthermore, satellite photography and other so-called national technical means can supplement seismic methods by providing evidence of suspicious activities or resolving the character of ambiguous seismic evidence. For example, explosions in porous soil which muffle the seismic signal and thus raise the detection threshold, often leave subsidence craters, which are plainly visible by satellite photography. Our Nevada test site is dotted with such craters. In sum, the test ban verification system that now seems attainable would so seriously limit opportunities for successful evasion that the risk of militarily significant Soviet cheating under the treaty would be minimal.

Regarding reliability of the U.S. stockpile, "proof-testing" is not necessary to maintain the reliability of the deterrent. In fact, it is one of the least often used methods in the U.S. program for checking and confirming continued weapons performance. Limited life components can be replaced, and random, rigorous inspection and testing can be conducted of all components—except the nuclear component, in which weapons designers have very high confidence. Most weapons experts agree that difficulties of maintaining stockpile confidence are likely to materialize only in the long term—if at all.

The treaty we are negotiating would last only five years—with no commitment beyond. At the end of that period we could reassess the desirability of extending a CTB for an additional term, taking into account our confidence in or concerns about Soviet compliance in the interim. Were we to continue a CTB for a longer period, I agree with Will's assessment of the advantage to the United States of the end of "proof-testing." As he wrote, "The mutual degradation of nuclear stockpiles over several decades might enhance deterrence because it would inhibit planning for an aggressive war."

Regarding the implications of a CTB on U.S. ability to maintain scientific skills important for national security, there is indeed no "unacceptable asymmetry" as claimed by Will vis-a-vis the Soviet Union. In the history of man's learning, coercion has not qualified as a generator of creativity. In the whole breadth of U.S. basic research and development programs—including the necessary safeguard program for maintaining out stockpile by diagnostic techniques short of nuclear tests—there exist many opportunities to sustain and nourish U.S. competence in nuclear-weapons technology.

Regarding military implications, in view of our substantial lead over the Soviets in nuclear-weapons design, our technological superiority in this important area would, in effect, be frozen by a CTB. One of its most important effects would be to constrain seriously the modernization of Soviet strategic forces. By putting a lid on yield-to-weight ratios of nuclear warheads, it would limit the Soviets' ability to increase the number of warheads per missile without paying a substantial penalty in yield. And since cruise missiles place a high premium on miniaturization, a CTB could well place obstacles in the way of an efficient Soviet cruise-missile force.

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Surely those truly interested in our national security do not want to give up these military advantages that a CTB would confer on us.

Above all, a CTB would be a major asset to our global non-proliferation efforts. The suggestion that our signing a CTB would be interpreted as a sign of weakness by our allies, who might then be encouraged to go nuclear, is totally at variance with the facts. Not only has Great Britain joined us at the negotiations, but, furthermore, our allies recognize that a CTB would impose important constraints on the Soviets, and all have strongly supported our efforts to achieve a treaty. Moreover, a CTB would make the superpowers' call for restraint more credible to other nations, and for those nations that did sign, a CTB would place a major roadblock in the way of their developing a nuclear option of their own.

APPENDIX 61

ARTICLE FROM MAY 28, 1985, WASHINGTON POST ENTITLED "TWO TREATIES READY TO GO" [1]

(By Larry Pressler)

In moving toward a major breakthrough on strategic arms reductions, let us not forget the need for some modest but important steps in the interim. In this, consideration should be given to the ratification of two negotiated and signed accords limiting nuclear weapons tests, the Threshold Test Ban (TTB) and the Peaceful Nuclear Explosion (PNE) treaties.

The TTB and the PNE were negotiated and signed between 1974 and 1976 by the Nixon and Ford administrations. The TTB prohibits all weapons tests with yields greater than 150 kilotons. The PNE accord places the same constraints on socalled peaceful nuclear explosions. The Soviets have looked favorably toward PNEs and the United States has not. The United States has concluded that in most instances chemical explosives are sufficient for civil projects, and they avoid the radioactivity problems associated with PNEs. For this reason, the PNE treaty will have a greater impact on Moscow.

Some quarters in the bureaucracy advocate that we not ratify the TTB and PNE so that we can retain the option of testing high-yield weapons. But as Gen. David Jones, chairman of the Joint Chiefs of Staff, has indicated, there are no plans for such tests; nor is there any real need to conduct them. Assuring reliability of our current stockpile of weapons can be achieved under the 150-kiloton level. Moreover, the Soviets are in a better position to profit from a move toward high-yield testing than is the United States. Moscow has ready-made facilities for such tests; we would have to start from scratch. There are few guarantees that Congress would fund such a program if we rather than the Soviets initiated testing above the threshold.

More important still is the likely impact of the 150-kiloton level upon the Soviet arsenal. The Soviets have long held a preference for multi-megaton weapons. These agreements would, therefore, be far more restrictive on them. If doubts on weapons reliability arose, this would first occur in Moscow. In the long term, moreover, the agreements might add to strategic stability. As new weapons came on line, their warheads would have to be tested to assure reliability. Likely Soviet doubts on the effectiveness of untested weapons might act as an incentive to move away from monster first-strike warheads.

Perhaps the most important provisions in these agreements deal with verification. The TTB provides for the exchange of geological and other test-related data required to assure compliance. The PNE's verification provisions are unprecedented. For the first time, the Soviets have agreed to on-site inspection.

The Reagan administration has made Soviet cooperation on the exchange of military data and on intrusive verification a litmus test of Soviet sincerity in arms restraint. The president's important strategic reductions initiative will depend on progress on these issues. The PNE and TTB offer Soviet concessions on both counts.

Support for ratification of these agreements has recently come from a broad spectrum of individuals, "hawks" as well as "doves." The group includes a stream of witnesses from the administration and the wider national security community who have testified before the Senate Foreign Relations Committee.

Since 1976 we and the Soviets have lived by these agreements—neither side has tested above the 150-kiloton level, and both have issued statements promising to adhere to the threshold as long as the other side does the same. But only ratification would bring the real benefits. Only then would the Soviets provide the data promised during negotiations and only then would they be bound to allow on-site inspection.

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APPENDIX 62

WASHINGTON POST EDITORIAL OF JUNE 24, 1984, ENTITLED "NUCLEAR WEAPONS TESTING" [1]

The Senate has urged President Reagan to send up for ratification the two companion treaties the United States and the Soviet Union negotiated in the mid-1970s barring underground nuclear tests over a certain size; smaller tests could continue. You could say that the distinguished senators saw a chance for an easy peace vote, since no one could have been under any illusion that Mr. Reagan would do what they wanted. Many legislators doubtless had in mind not so much achieving a vital arms control agreement as lending symbolic encouragement to the whole stalled process of arms control. The treaties after all are no longer on center stage, and the two powers both say they're honoring the terms anyway.

Still, the two treaties deserve real action. In the 1960s and 1970s, a principal purpose of arms control was to cut off new weapons by outlawing testing. All but underground nuclear tests were banned in 1963. But the ban, far from curbing weapons work, may have expedited it by forcing tests into an environment out of the public eye. Pressing on for a comprehensive test ban, arms controllers finally got an agreement on a 150-kiloton ceiling on underground explosions, military and "peaceful."

Jimmy Carter, however fearing that these lesser treaties would clutter his pursuit for a grand comprehensive ban, pulled them back from the Senate. That was a mistake, and Ronald Reagan soon added his own. Declaring inadequate the treaties' unprecedented provisions for on-site instrumentation and inspection, he demanded that Moscow negotiate tougher verification measures. Moscow refused, preferring first to ratify the treaties. There, in limbo, they now repose.

On the matter of a comprehensive test ban, things are the same. The administration, declining to resume negotiations on a treaty, has offered simply to discuss, not negotiate, verification and compliance—in a 40-nation echo chamber in Geneva. Moscow says it wants treaty negotiations, not a charade. Whether the administration really thinks a tougher treaty is obtainable or necessary, or whether its purpose is simply to stall and conduct more weapons tests, remains open to debate.

In fact, the particular status of the testing treaties is at this point not so important as the nature of the political currents that have becalmed them. Mr. Reagan took a radical new approach to arms control when he came to power. He rejected the premise of all previous administrations that rough parity existed and that the task of arms control was to ratify it and, step by step, to reduce its costs and risks. His premise was that first an arms imbalance in the Soviets' favor needed to be righted and then arms control was to do its job—by great leaps forward. In this scheme there has so far been no place for the testing treaties or, for that matter, for any kind of new arms control at all.

In brief, President Reagan rejected the incremental and imperfect gains registered by one process and has nothing to show from the process he installed in its place. How Americans feel as a result is one of the principal questions that will be tested in the 1984 elections.

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APPENDIX 63

ARTICLE FROM JUNE 3, 1983, WASHINGTON POST ENTITLED "DOUBT CAST ON SOVIET VIOLATIONS" [1]

(By John R. Wilke)

Two new studies dispute President Reagan's suggestion in recent weeks that Soviet underground nuclear weapons tests may have violated the limits of a 1974 treaty.

The studies by geophysicists at Columbia University, the University of Colorado and the U.S. Geological Survey found that the Soviet tests have fallen within the 150-kiloton explosive limit imposed by the Threshold Test Ban Treaty.

"Over the past five years the size of the largest Soviet tests come very close to 150 kilotons, but none appear to have exceeded the limit," Columbia professor Lynn R. Sykes said in an interview.

Reagan said last month that there was "reason to believe that there have been numerous violations" of the treaty but offered no evidence.

An administration official said last night that "we have never made the allegation" that the Soviets violated the treaty, but "we do have concerns that there may have been tests in excess of the limit." The official added that verification procedures "are not sufficient" to provide absolute proof. Last year, criticizing verification procedures in the 1974 treaty and citing the need to test new weapons, the Reagan administration decided not to resume talks with the Soviet Union and Great Britain on a comprehensive test ban treaty begun in the Carter administration.

The administration instead sought revision of the 1974 agreement because of concern that the Soviets may have detonated weapons larger than the accord allows.

The Soviets refused to renegotiate, calling instead for resumption of the comprehensive test ban negotiations.

Sykes was a member of the U.S. team that negotiated the 1974 treaty and is widely regarded as one of the nation's top seismic scientists. He conducted extensive research for Air Force in the 1970s on underground test detection, and is an adviser with the Defense Advanced Research Projects Agency (DARPA).

Sykes and co-author Ines Cifuentes of Columbia's Lamont-Doherty Geological Observatory presented their findings yesterday at a meeting of the American Geophysical Union in Baltimore.

In a summary of his technical paper, Sykes said in an interview that the allegations made by Reagan and others "are based on a systematic overestimation of the relation between seismic magnitude and explosive yield," an effect he attributed to the different geologic characteristics of the Soviet and U.S. test sites.

A second paper challenging the suggestions of treaty violations was presented by Dr. Charles B. Archambeau of the University of Colorado and former DARPA scientist Dr. Jack F. Evernden, now a senior researcher for the U.S. Geological Survey in Menlo Park, Calif. "Based on both seismic body and surface wave magnitude estimates, the U.S.S.R. appears to be complying with the 150-kiloton limit," the report said.

The scientists' conclusions are supported by a classified study conducted for the Defense Department at the Lawrence Livermore National Laboratory in California, according to sources there.

"Whatever it is believed in Washington, it is now clear that officials here at Livermore lab do not believe that the Soviets have violated the 150-kiloton limit," a Livermore physicist said.

"We even show violations for some of our own shots" when estimating from the seismic data, added Robert W. Alewine of DARPA in another presentation. "One looked as high as 265 kilotons," he said, "and the Russians called us on that one."

Although Alewine agreed with Sykes, Evernden and others about the need to correct for the different geologic characteristics of the U.S. test site in Nevada and the test sites in the Soviet Union, he used a correcting factor half that employed by Sykes. Using this approach, he said, the largest Soviet test was calculated at about 300 kilotons.

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APPENDIX 64

EXCERPT FROM THE BOOK "THE FUTURE OF NUCLEAR TESTS" BY HANS A. BETHE AND EDWARD TELLER

The Case for Continuing Nuclear Tests

by Edward Teller

THERE ARE THREE QUESTIONS CONNECTED with testing of nuclear weapons which deserve careful public discussion. Is it worthwhile to continue testing? Is it feasible to supervise an agreement on test cessation? And what should be done about future nuclear tests?

Expert Judgment Needed

Some of the answers to these questions are of a technical nature. The statements in this field cannot be readily checked by the layman. This is true both because of the complexity of the situation and because of the fact that details concerning nuclear explosives continue to be held as classified information. Secrecy interferes with the formation of public opinion based on objective knowledge. Under these circumstances informed technical experts bear an added burden of responsibility. They must express themselves with as much objectivity as is humanly possible.

It is also obvious that the questions to be discussed are connected with many policy problems which do not lie in the field of the technical expert. Perhaps it might be considered wiser if a technical specialist would abstain from discussing these topics.

On the other hand, the problems mentioned above are closely interwoven and it is hard to draw the line where the technical judgment ceases and the political discussion begins. In fact, it may be preferable to discuss fully the whole complex of questions involved. Such discussion will reveal whatever bias the writer has and will therefore give a more complete picture to the non-technical audience.

IS THE A-BOMB THE ULTIMATE WEAPON?

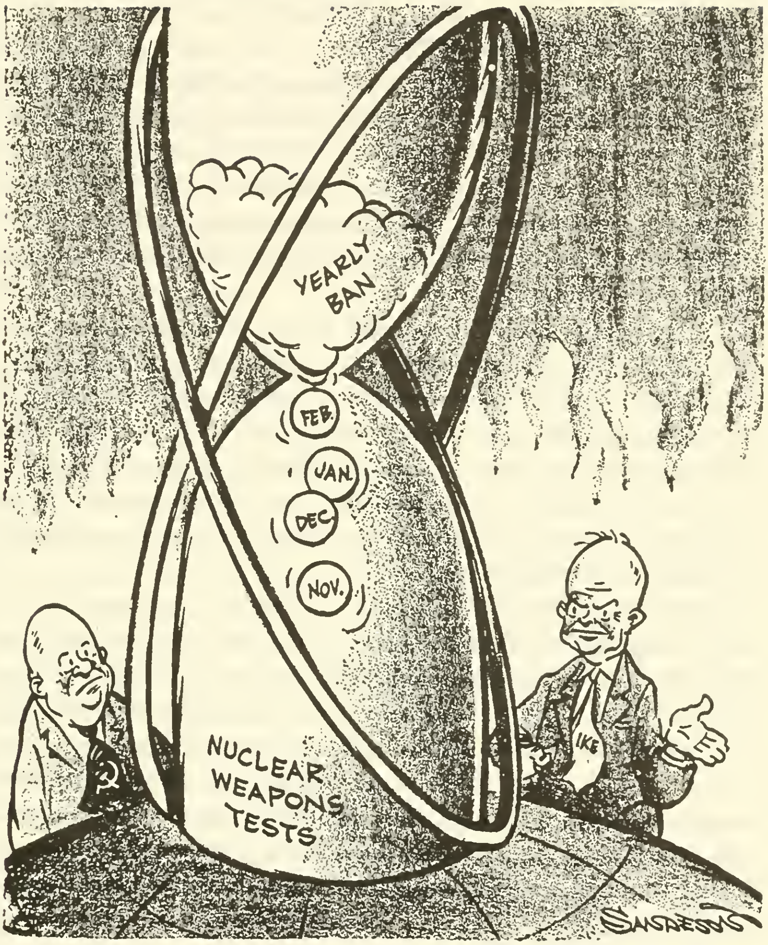
The power of nuclear bombs surpasses conventional explosives to a degree which is not easily visualized by anyone. It is therefore not surprising that right after the first nuclear explosions the majority of American people, whether they knew much or little about the subject, believed that no further developments would take place. A man who was rightly considered as the greatest expert in this field said toward the end of 1945, "We have accomplished wonderful things in Los Alamos. It will be many years before anybody will be able to improve on them."

Similar prophecies were made in the years that followed. Again and again they have proved to be wrong. I myself frequently have made errors of considerable magnitude when I attempted to forecast future developments. I always erred in the direction of underestimating new possibilities.

New Improvements Go On

The fact is that in the last 15 years we have learned how to increase the explosive force a thousandfold, and we have made great strides in reducing the weight of a bomb of a given power. We have decreased the expense of the biggest nuclear explosives to a point where this expense is no longer an essential factor. On the other hand, small nuclear explosives for tactical purposes are still limited in their usefulness because of their cost. We have made considerable progress in reducing the radioactivity produced by big nuclear explosives, but small nuclear explosives continue to produce the standard amount of radioactivity. We

Our Mark Time Hour Glass



Sandeson in *The Fort Wayne News-Sentinel*

have made nuclear explosives much safer, much easier to handle and much more adaptable to specific purposes. The majority of these purposes are connected with wartime operations such as the sinking of a submarine or the destruction of a plane. All this has been accomplished by improvements which added each year new and often surprising details to our nuclear devices.

Need for 'Second Strike Force'

The image in the popular mind is quite different. One fact has registered. Instead of kilotons we can now produce megatons. This is not the result of any so-called breakthrough, as is commonly believed, but has been made possible by the steady continuing accumulation of know-how over a period of years. The process of improvement will continue unless research and nuclear testing are discouraged.

At present there is no intention to build bigger nuclear explosives. There is one, and to my mind only one, justification for a great arsenal of megaton bombs: to deter the use of these big explosives against our own country. But if this purpose of deterring attack is to be made really effective we must have what is technically called a "second strike force." This means a force which can survive an all-out nuclear attack on our country and still deliver a counterblow.

It may seem difficult to make sure that our own nuclear explosives and their means of delivery will not be destroyed. But there are several ways in which this can be achieved. A large fraction of our Air Force may be put on continuous air alert. Our bases could be so strengthened as to withstand all but the most accurate hits by the biggest enemy bombs. Finally, we could disperse our counterforce and change the location of our missiles with sufficient frequency so that it would be difficult for an enemy to keep track of them. I believe that the last alternative is the most feasible one.

Once we possess such a second strike force we can eliminate all thought of a "preventive" strike. We need not act on mere suspicion, and we can clearly reiterate that we shall not start an all-out war and shall use our big strike force only in self-defense.

Such a statement could be backed up by adequate civilian defense to safeguard our population and insure our national survival. All of this is possible but quite difficult, and it will require novel and imaginative approaches. One step which will make this program much easier to execute is to decrease the weight of our retaliatory weapons by a considerable factor.

Reduction of Weight Essential

Such a reduction of weight is indeed most important. A second strike force is expensive. Its cost runs to many billions of dollars. It is not easy to protect a missile so that it can survive a megaton attack. It is difficult to move big rockets around the country in complete secrecy. It is expensive to construct atomic submarines which can carry a sufficient number of heavy missiles.

A reduction of the weight of the explosive would reduce the weight of the rocket which has to carry the explosive. This would greatly simplify the task of establishing a second strike force. Whether or not we can construct such a force could well determine our national survival during the next one or two decades. By relatively inexpensive research and by nuclear experimentation which is called testing, we can establish reliable defenses and incidentally save a national effort which is represented by a figure of perhaps $10 billion.

Value of Small Tactical Bombs

Further development of small tactical bombs might be even more important. In a situation where neither of the two greatest powers dares attack its opponent directly, the possibility of limited warfare continues as a menace to peace. Each of the two sides does have a strong interest in limiting the territory and the aims of the conflict in order to avoid an all-out catastrophe. Arguments that nuclear weapons if used anywhere will precipitate all-out war are credible only as long as one or the other side finds that all-out war is to its advantage. I am certain that we shall not make such a dreadful and insane decision and feel sure the Russians will not either.

One can argue that we should not initiate the use of tactical nuclear weapons in limited warfare. In any case we would put ourselves into a dangerously weak position if we neglected the possibility that the Russians might embark on such limited usage, particularly if we did not have the necessary tactical weapons to use in opposition. Therefore it is an absolute necessity that we should develop tactical nuclear explosives.

We Do Not Know Who Is Ahead

It has been stated that we are ahead of the U.S.S.R. in tactical weapons. Because tactical weapons have low yields, it is difficult if not impossible to observe the testing of such weapons. For example, some of the most interesting tactical explosives have yields less than a thousand tons. Below five thousand tons our observations of Soviet tests are uncertain and incomplete. Below one thousand tons we have at present no means of observation. Therefore we do not know whether we or the Russians are ahead in this important field.

In the United States, interest in tactical nuclear explosions has increased rapidly during the past few years. There are many exceedingly important additional improvements which we now have on the drawing board. Some of these improvements would make our explosives easier to carry and to deliver. Others would make the weapons less expensive and therefore available in greater numbers. Still others would allow us to use nuclear explosives with much greater discrimination. All of these developments also would mean that our requirements for military manpower could be substantially reduced.

These tactical weapons are of low enough yield so that even when used in considerable numbers they do not produce an excessive radioactive contamination. Further research would make it possible to reduce this contamination to an insignificant level.

Proper development of nuclear weapons could bring about a situation where nuclear warfare need not overhit any target and could be sparing of the lives and the property of noncombatants. Our aim should be to destroy the war machine of the aggressor and to save human lives. It is my opinion that if we continue our present weapons development, this aim can be achieved. However, such a development requires further weapons testing.

Project Plowshare

This discussion would remain incomplete if I did not mention the possibility of peaceful uses of nuclear explosives, which we call Project Plowshare.

There are excellent and convincing experiments and arguments which indicate that these peaceful applications can be carried out, and that they will permit important projects which otherwise would not be feasible or economical. Further development of nuclear explosives could add much to the safety and economic feasibility of Plowshare. For instance, one may use nuclear explosives to move great amounts of earth. One may dig canals or one may blow away hundreds of feet of rock and dirt in order to expose massive deposits of iron or coal for pit mining. For this we need explosives which are cheap, flexible and, above all, clean. We have sound plans to accomplish all this. But we need more nuclear tests.

The field of nuclear explosives is young and challenging. If one side in the world conflict carries out vigorous work while the other remains idle, that side will come into possession of decisive advantages. Our opponent will be better prepared for an all-out conflict, will be superior in limited warfare, and will reap important advantages in peaceful uses of atomic energy.

CAN TEST CESSATION BE POLICED?

A method to detect nuclear explosions in the atmosphere has been functioning for many years. It is true that for smaller shots of approximately a few kilotons this method becomes uncertain. But the situation is relatively easily remedied. Some additional inspection stations and appropriately scheduled flights over the territories of each of the great powers which possess nuclear bombs will allow detection and identification of shots down to one kiloton.

Shots below one kiloton are among the most interesting. These shots could not be detected with assurance by the system which has been proposed at the nuclear conference in Geneva. However, if the shots are in the atmosphere, an unexpected change in wind direction could transport telltale radioactivity toward a control station. It is not necessary to detect every single violation. It is only important to prevent systematic violations. The atmospheric control system is probably good enough to do that.

Nuclear explosions under the ocean are similarly open to detection. In this case it may not be possible to identify the violator, but at least we could have some chance of finding out that a violation did take place.

Atmosphere, Ocean Tests Could Be Stopped —

It would seem to me perfectly reasonable to announce that we will henceforth abstain from weapons testing in the atmosphere and in the ocean. Our action could be unilateral. We would, of course, challenge the U.S.S.R. to do likewise and we should also ask them to support a move in the United Nations requesting all other countries to abstain from this kind of experimentation.

I do not maintain that such a very limited moratorium would have any great advantage. It would actually stop further contamination of the biosphere, the sphere of living beings, by weapons testing. Feelings on contamination are strong throughout the world, and the Russians themselves have denounced atmospheric contamination.

Moreover, a weapons test moratorium in the biosphere would indeed be a first step which has the great advantage that it can be reasonably well policed. Those who argue that a first step is in itself valuable should support such a proposal.

— But Not Underground Tests

The situation is quite different with respect to underground tests and tests in outer space. Such tests can be carried out without exposing any person to the slightest radioactivity. Moreover, these tests can be effectively hidden in such a manner that even long systematic series of nuclear experiments can be carried out without any real chance that such series will be detected by any technical observation. We have sufficient evidence to make us confident that such series can be used to yield practically all the information which is needed for a successful development of nuclear explosives.

The possibility of detecting underground explosions has received a great deal of attention. The proposed procedure consists in obtaining the locations of underground disturbances by seismographic measurements and in determining by on-site inspection whether such an event has been due to a nuclear explosion or to an earthquake.

We have heard most about the question of how many inspections a year would be permitted. After exceedingly great delays the Russians have suggested three annual inspections in their country. This number is an extremely small fraction of those earthquakes which the seismographs cannot distinguish from nuclear explosions.

Is Inspection Possible?

But further difficulties exist. How will the inspection team determine whether or not a nuclear explosion has taken place? If simple and well-known procedures are followed, the explosion itself will not leave any mark on the surface. A reliable distinction between an earthquake and an explosion can be obtained only by finding the radioactivity produced by the explosion. This radioactivity, deposited at an unknown depth, will be limited to a few hundred feet from the explosion point. All that the seismographs can tell us is that the event occurred in an area which is approximately one hundred square miles. If the Russians took pains to cover their tracks, we might as well look for a needle in a haystack.

Under these conditions one would have to rely on intelligence information to find out whether or not unusual activities had preceded the earth movement. One would have to find out at what point the shaft or the tunnel had been dug into which the nuclear explosive had been placed. With such information one could indeed find the radioactivity. But at present intelligence work is of questionable value and would lead to considerable friction.

The situation could be improved if the seismograph could distinguish most earthquakes from nuclear explosions. Attempts are being made to find more distinguishing marks, and there is a chance that such attempts will bear fruit. But so far the results are meager. Moreover, it seems possible to distort the signals from a nuclear explosion so that it appears like a natural event.

Muffling of Underground Shots

The difficult question of policing underground shots has become almost hopeless due to the discovery that underground explosions can be muffled or decoupled. By placing nuclear explosives in a cavity of appropriate size the signal can be decreased by a factor of more than 100. This is impressive, particularly if contrasted with possible improvements in the detection system. The most hopeful estimates of such improvements could increase the sensitivity only fivefold.

If a would-be violator should decouple his shots, systematic testing below 20 kilotons could not be detected. To detect shots above 20,000 tons, 600 robot stations in the Soviet Union alone are needed. Unfortunately there are in Russia each year approximately 5,000 earth movements which would give the kind of signals we are discussing here. Due to the unsatisfactory state of this discrimination between natural earthquakes and artificial ones, practically all of these 5,000 movements would have to be considered suspect. This poses an enormous problem of inspection.

Use of Cavities Practical

But is it, in fact, practical to build the cavities needed for the decoupling? It has been argued that the expense of the excavation would be prohibitive. The process of excavation, it is also said, would be too conspicuous. These arguments are of limited validity.

The cheapest known method of producing cavities of required size is to wash them out from thick salt deposits. Available reliable engineering figures show that a cavity accommodating 20 kilotons can be produced in two years for $10 million. This is not excessive in view of the considerable importance of nuclear tests. The establishment and maintenance of the control system is likely to cost more than the amount which would have to be spent to outwit the technical inspection, even if we consider systematic and extended nuclear test series.

If the excavation is performed by washing out a cavity, the number of people and equipment employed would not be particularly conspicuous. The question of disposing of the salt has been raised. It seems to me that this problem is not very hard to solve. There are many places in the world in which the soil is porous enough so that one can dispose of the salt solution by pouring it on the surface or into relatively shallow holes. The salt might eventually be carried to some source of fresh water, but in appropriately chosen locations one can make sure that this will take a very great number of years.

If muffling could not be effected anywhere except in salt deposits, the areas which would have to be inspected would be very greatly decreased. Actually it is not too difficult to make an appropriate cavity in limestone. Moreover, the big cavities which are usually discussed are needed only if maximum decoupling is to be attained. Cavities of one-tenth the volume are sufficient to decouple a shot by a factor of 20 or 30. For smaller shots such cavities could be readily excavated by completely conventional methods.

Thus the reader will clearly see that the question of underground detection is complicated. But the following simple summary may serve as a guide.

Systematic violations under one kiloton can be carried out without any difficulty. It is probable that such systematic violations can be extended into the region of a few kilotons and quite probably up to 20 kilotons. Above 100 kilotons systematic violations will almost certainly become extremely difficult to conceal.

Outer Space Testing

It seems strange that so much attention is given to underground testing and all but none to testing in interplanetary space. The latter is theoretically feasible and even more difficult to police.

It is possible to send out a rocket which carries a nuclear explosive as well as observation equipment. Once the missile has attained the appropriate distance from the earth the compartments containing the explosive and observing equipment are separated and allowed to drift apart. When they have drifted apart to an appropriate distance (let us say ten miles) the explosion takes place. The conditions under which the observations are carried out are, of course, quite different from those prevailing on earth. The absence of the atmosphere makes some observations easier, while the absence of heavy equipment will exclude some other measurements. It is clear in any case that significant and sufficient observations can be performed. The results can then be sent back in a coded form which would not attract any attention. Secret explosions of this kind could be carried out at present up to many megatons.

Problems of Policing

It has been correctly stated that space testing up to a million miles could be policed by methods which seem feasible. A million miles is four times the distance to the moon and is essentially outside the gravitational field of our planet. Once the rocket has left the region of terrestrial gravity it can attain great distances without any further difficulty. If one wants an explosion at 50 million miles from the earth, one has to be patient for a few months and one has to carry an additional power supply of 30 pounds to signal back from the more remote location.

The policing of space tests has been carefully discussed. Policing is possible, but expensive. It is expected to be effective as long as the violator takes no countermeasures to conceal his explosions.

The hiding of space explosions makes it necessary to carry more weight in the rocket. This added weight will cost money. Policing makes it more expensive for the violator to operate, but it continues to permit his operation if the power of the explosion remains under a given limit. This limit in the case of space testing is given by quite a large figure—one-half megaton.

All these statements have been discussed in very considerable detail by American experts. The results have then been submitted to our British and Russian colleagues. Concerning the points I have mentioned above no objection was raised by any party.

It is not easy to make an estimate of the expense of space testing. Twenty million dollars per shot seems to be a reasonable figure. This figure is somewhat higher than the expense of big explosions in the past. It will be further raised if policing is established. However, we should remember that the main expense connected with space testing is due to the necessity of lifting heavy loads, a task in which the Russians excel.

WHAT ABOUT FUTURE TESTS?

In the two preceding sections I have confined myself to the discussion of known facts and to predictions based on technical knowledge. In this section I shall enter the field of political discussion. It is obvious that my personal judgment will influence my conclusions.

It has been amply demonstrated that if the Russians want to perform systematic clandestine tests they can do so. Whether or not they will do so, I do not know. I have some opinions about the probabilities. So does every one of my readers. A few statements in a discussion cannot change these probability estimates. Therefore a discussion of this topic seems to me futile.

There are, however, some other points where discussion can carry us somewhat farther.

Can U.S. Rely on Russia?

Can we be satisfied with a token inspection and rely on Soviet good will?

To my mind such a procedure is inconsistent. If we are willing to rely on the good intentions of the Russians we have no justification to go to all the trouble, incur all the expense and produce all the friction with which an inspection system is necessarily connected. If the inspection system does not give us any assurance against systematic violations, we should make it clear to ourselves that we are in fact simply accepting the word of the Russians. We may then proceed to consider whether or not we are wise to do so.

But, if our national policy continues to be based on *controlled* arms reduction, it is necessary that we should make the controls meaningful. If we do not do so, we mislead the American public.

The most frequent argument raised in support of a test ban is the hope that such a ban will be a first step leading to relaxation and further arms control. What has happened during the present two-year moratorium on nuclear tests and nuclear test negotiations does not justify such a hope. The period preceding our test moratorium corresponded to a lull in the cold war. Today militant gestures by Moscow in connection with West Berlin and Cuba, to mention only two points of tension, show an alarming increase in cold-war activities.

Moratorium Without Guarantee Dangerous

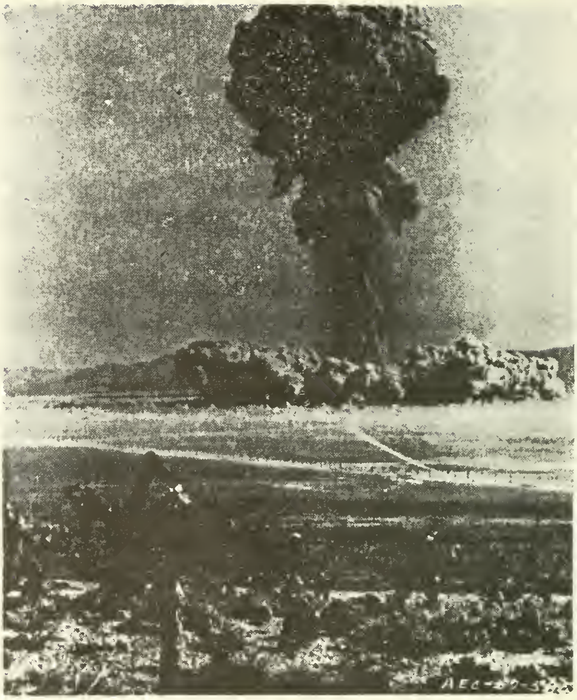
If we accept a test moratorium without a guarantee sufficient to insure against systematic Russian evasion, we must seriously consider the possibility that Soviet nuclear tests will put our adversaries into an exceedingly strong military position. Nuclear bombs are not the only weapons which are needed for a strong defense. The possible use of nuclear bombs, however, is inextricably connected with every one of the great dangers which face us. Military power alone will not stop the spread of communism nor will it solve the problems of the world. But if the Russians should secure a sufficiently great military advantage over other great powers, their dream of a Communist world empire might soon be realized. In view of these dangers I believe that we should resume weapons testing in those areas where control is not feasible—both underground and in interplanetary space.

If we resume such testing, what can we do to enhance the expectations of a stable peace? I should like to devote the concluding paragraphs to this question.

Scientific Secrecy Should Be Reduced

Discussions of the test ban have had a salutary consequence. These discussions have led to a clear realization that arms limitation cannot be insured by purely technical means, and that human contacts between both sides remain paramount. Satisfactory

Nevada Test Site . . .
the shot was fired
from a 500-ft.
tower in Yucca Flat ▶



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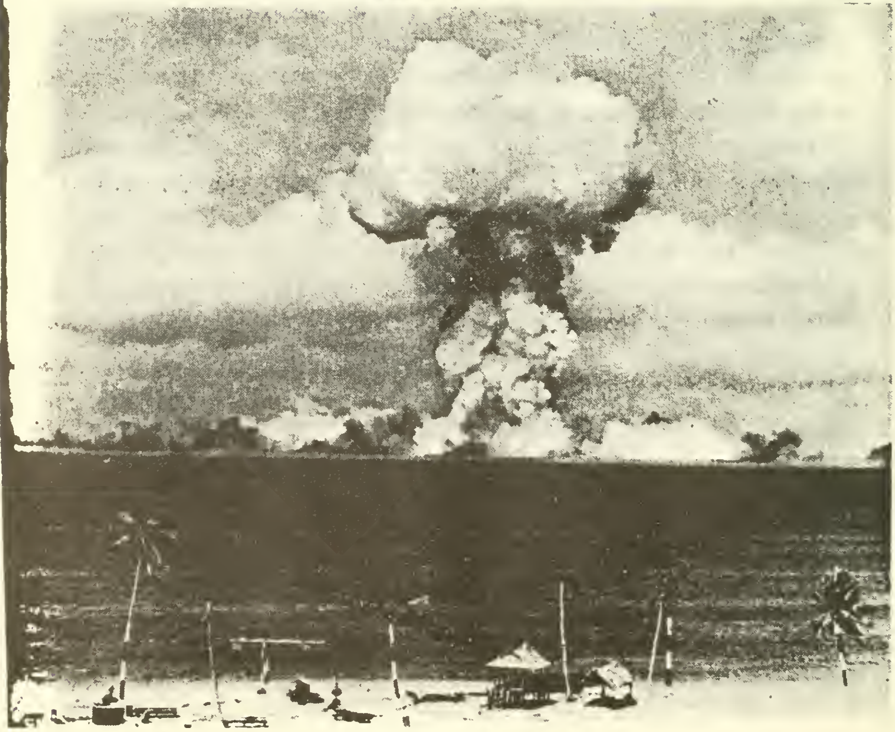

control of nuclear weapons could be achieved if technological secrecy would be eliminated so that we could learn from Soviet scientists about the status of their weapons research.

In this direction we could make a significant step. We could relax our present rules of secrecy with considerable advantage to ourselves and to our allies. We should use every effort to establish an open world in which the customary scientific interchange replaces the present technological secrecy.

If we reduce secrecy we can more fully participate in building a better world and in fostering the technological progress which promises to assure a decent livelihood for all people on the globe. Similarly, we must participate in the supranational organizations without which technological progress cannot be put to full use. We should be ready to cooperate with everyone, including the Russians, in constructive enterprises which will help to improve the lot of mankind.

As an example of such an activity, I might return to the peaceful use of nuclear explosives which has been called Project Plowshare. Such nuclear shots used for engineering purposes could be performed under international supervision. The purpose of each shot should be stated, and it can be easily demonstrated that the purpose is in fact served by the explosion.

Peaceful Cooperation Urged

Among those projects which can be performed successfully we have mentioned the digging of canals and the use of open-pit mining for critical raw materials such as iron, coal and bituminous substances. There are many who believe that the availability of such raw materials is among the most important factors determining war and peace.

But Plowshare is only one of the fruitful fields we should explore. In weather research, in medical science, and in many other scientific and technical endeavors we can join our friends and our present opponents in making great and beneficial progress.

Our generation faces a many-faceted problem. We must create a community of nations which is free from coercion and intolerable want. To be able to work toward this goal we need peace. We cannot have peace without strength. At the same time we must use all our power and all our imagination to make the best use of the peaceful years which lie ahead of us.

It is my opinion that a test ban and the cessation of nuclear experimentation would only create an uneasy illusion of security. Real security and real peace can be better reached by developing our technical means, including our nuclear explosives, both for defense and for constructive peacetime purposes.

Discussion Questions

1. What are the principal arguments for disarmament and what are those for preparedness? What is meant by "disarmament" and by "preparedness"?

2. Is one-sided disarmament desirable?

3. Can a ban on test cessation be supervised?

4. What technical developments are likely to result from further testing?

5. Can nuclear explosions be used for peaceful purposes? If so, for what purposes?

6. How are the questions of a test ban, of secrecy and of an open world connected with each other?

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Dr. Bethe Comments on Dr. Teller's Views

Dr. Teller argues persuasively that our military goal must be a "second strike force"—that is, a force which can survive an all-out nuclear attack and still deliver a counterblow. With this conclusion I agree completely, and have agreed in the past.

I do not believe, however, that we need further development of atomic weapons for the establishment of such a second strike force. Our present stockpile of nuclear weapons and those which can be designed on the basis of past tests are adequate. Submarines carrying Polaris missiles are now joining our fleet and will constitute the first, and very important, part of our second strike force. It can be safely assumed that a nuclear warhead for these missiles exists. Plans for mobile missiles on land (Minuteman), to be carried by railroad trains or trucks, are well advanced.

The situation on tactical atomic weapons is similar, although somewhat more complicated.

Agreement — and Disagreement

In order to maintain and improve our military strength we need to develop many new weapons. One of the most ambitious new weapons is an antimissile missile. Another important problem is to provide better communications which would survive during a nuclear attack. These areas of study and experimentation are in my opinion much more important to our defense than further development of atomic weapons. We should also develop modern methods to conduct a limited war without nuclear weapons.

I agree entirely with Dr. Teller's comment that "we should be ready to cooperate with everyone, including the Russians, in constructive enterprises which will help to improve the lot of mankind." However, we should select such areas for cooperation as are likely to be acceptable to the Russians and most useful to underdeveloped countries. Biology and medicine seem to be obvious choices to help the underdeveloped countries. The non-secret parts of nuclear physics, such as the building of large accelerators, can easily evoke enthusiasm among scientists in both the U.S.S.R. and the United States. The Plowshare project, being connected with atomic weapons, seems one of the more difficult fields of cooperation. Nevertheless, the position of the United States at the Geneva conference has been that Plowshare experiments should be permitted under international inspection and under carefully controlled conditions which would prevent misuse of Plowshare experiments for further development of atomic weapons.

Dr. Teller Answers Dr. Bethe

There can be no question about the correctness of Dr. Bethe's position that Polaris and Minuteman are most essential in the establishment of a second strike force. It is unfortunate that we live in an "Alice in Wonderland" world: we must run very fast to stay in the same place. The main issue between Dr. Bethe and myself is connected with the need and the possibility to run fast

Visual Aids*

Atomic Timetable, Part II. Produced in 1958 by CBS-TV "See It Now" series. [illegible] min. Rental, $15.00, from New York University Film Library, 26 Washington Place, New York 3, N.Y. Edward R. Murrow interviews Willard Libby of the Atomic Energy Commission, Hermann Muller, geneticist, Linus Pauling, physicist, and others, who discuss whether continued atomic testing would be a major threat to civilization.

Teller-Pauling Debate: Fallout and Disarmament. Produced in 1958 by KQED, San Francisco. 60 min. Rental, $8.00, from NET Film Services, Indiana University, Bloomington, Ind. Presents a debate on the problem of radioactive fallout from nuclear tests and the advisability of nuclear disarmament. Features Doctors Linus Pauling and Edward Teller.

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* Unless otherwise noted, all films are 16 mm, and in black and white.

Glossary

Decoupling: The process of reducing the size of the seismic signals from an underground explosion by detonation of the explosive in a large hole underground.

Kiloton: Explosive energy release corresponding to 1,000 tons of the chemical high explosive, TNT. The bomb detonated at Hiroshima near the conclusion of World War II was equivalent in size to 20 kilotons of TNT.

Megaton: Equivalent of 1,000 kilotons or 1 million tons of chemical explosive (TNT).

Nevada tuff: A weakly cemented, rather crumbly rock, formed from volcanic ash. The underground nuclear explosions of Hardtack II, as well as the Rainier explosion, occurred in this rock, which is somewhat elastic and produces stronger seismic signals from nuclear explosions than are produced by the same size explosions in salt and granite.

Seismogram: The record of an earth tremor.

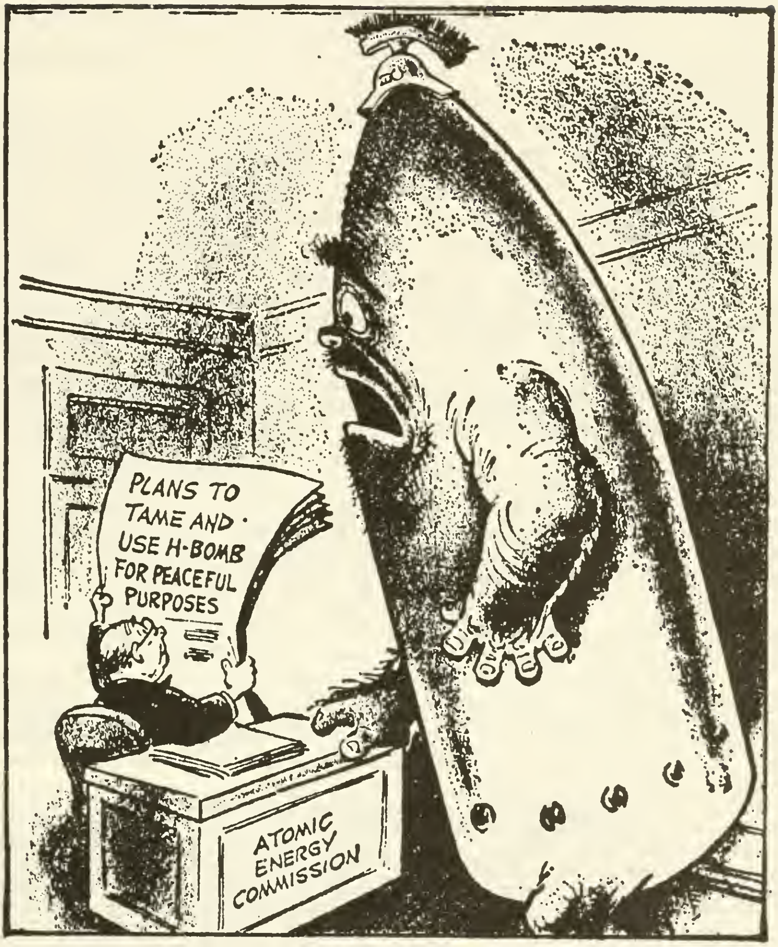
Seismograph: An instrument for detecting and recording small vibrations in the earth's crust. The detector portion, called a seismometer, usually consists of a mass suspended from a frame either by springs or as a pendulum, in such a manner as to tend to remain [illegible] the earth.

[illegible] below 20 kilotons. This class is often referred to as "low [illegible] weapons."

Threshold: A seismograph of a given sensitivity placed a known distance from an underground explosion or earthquake will record relatively large earthquakes and underground explosions. As the magnitude of the earthquake or equivalent yield of the explosion is reduced it becomes more and more difficult to detect the signature of these events on the seismograph. Eventually one reaches a "threshold" which is defined as the smallest earthquake or underground nuclear explosion which can be clearly detected.

Yield: Energy release.

TAMING THE BOMB


PLANS TO TAME AND USE H-BOMB FOR PEACEFUL PURPOSES
ATOMIC ENERGY COMMISSION

Shanks in *The Buffalo Evening News*

'W-What's a plowshare?'

APPENDIX 65

Letter From Former President Carter to Chairman Fascell Concerning Recommendations Adopted at Emory University Conference on International Security and Arms Control

April 18, 1985.

Hon. Dante Fascell,
U.S. House of Representatives, Washington, DC.

To: Representative Dante Fascell: During this past week, the Carter Center of Emory University conducted a consultation on International Security and Arms Control. For five days, a distinguished group of experts from several countries assessed the subjects of alliances, regional conflict, proliferation, weapons, strategy, doctrine, negotiations, and diplomatic-political aspects of U.S.-Soviet relations. A list of the active participants is attached.

The final two days were public sessions, reported by heavy press coverage including eleven hours of continuing live television through the Cable News Network. There were often heated exchanges, but abusive rhetoric was minimal. All of us benefitted from the detailed discussions, especially concerning U.S.-Soviet relations, with an emphasis on arms control. Derived from the analyses, some unanimous recommendations were presented at the final public session. Those who agreed on these recommendations were Presidents Gerald Ford and I, the Soviet delegation. Senators Sam Nunn and Howard Baker, former Secretary of State Cyrus Vance, and the three panel chairmen, General Brent Scowcroft, Dr. Robert O'Neill, and Ambassador Ralph Earle.

For your interest, I have listed below some of the more significant recommendations that apply specifically to arms control.

1. The United States and the Soviet Union should continue to adhere to the Anti-Ballistic Missile Treaty and the Outer Space Treaty and no steps should be taken contrary to the the terms of those agreements until prior negotiations have been exhausted. Research is permitted by the ABM Treaty, but development and testing as proposed in the U.S. Strategic Defense Initiative are not. Through negotiation, the parties should clarify the terms of the ABM Treaty to distinguish between research and development, and there should be a clear notice of any possible plans to abrogate or deliberately violate the treaty's terms.

2. The Unites States and the Soviet Union should continue their existing policies of not taking steps to undercut the provisions of important treaties and other agreements that are not formally in effect, including the interim Agreement of Offensive Arms, the Threshold Test Ban Treaty, and SALT II. Definitions and other non-controversial provisions of these agreements should be accepted as an integral part of ongoing or future negotiations.

3. Based on the U.S.-Soviet Union joint statement establishing the present Geneva talks, the two nations should make every effort to reduce greatly and further limit offensive nuclear arms, without letting the possibility of future developments in strategic defensive systems inhibit such reductions and limitations. The Soviet side appears to be unwilling to consider deep reductions in offensive weapons as long as the possibility of new strategic defensive deployments is not definitely foreclosed; the American side wishes to negotiate precisely such deep reductions while holding open the strategic defense option pending completion of research to establish its feasibility. Any such agreement should provide for a more stable balance, with weapons that contribute to overall strategic stability.

4. The sides should take more constructive and imaginative steps regarding verification of compliance with agreements, including cooperative measures that may include on-site inspection as appropriate and necessary to enhance such verification. (This was an important suggestion that came from the Soviet representatives during discussions about the Krasnoyarsk radar.) In this connection, issues of compliance should be resolved by both sides in a manner aimed at their resolution, not their exploitation for political or propaganda purposes, and the same criterion should be applied to negotiations themselves.

5. The United States and the Soviet Union should address with the utmost priority the question of establishing mechanisms aimed at crisis prevention and crisis management in order to avoid misunderstandings and/or miscalculations that could lead to conflict. Frequent and regular meetings of senior political and military leaders would be desirable.

6. In present and future negotiations, agreement on key issues should be implemented step-by-step through executive action, without waiting for a final compre-

hensive document to be signed before the benefits of such interim progress might be realized.

7. The parties should now begin to examine how to reduce offensive arsenals enough to minimize the incentives of either side to deploy extensive strategic defenses. Such a goal could be a relatively small number of single-warhead launchers (perhaps 2000) deployed as invulnerably as possible—in a mobile mode, in deep and hardened silos on the protected southern side of mountain ranges, or in ocean safe havens. The exact number is not as important as survivability and assured deterrence. Prior to the implementation of such a decision by the superpowers it will be necessary to induce the other nuclear nations to accept a comparable reduction in their arsenals.

8. The United States should ratify the Threshold Test Ban Treaty, or make it clear that its terms will continue to be honored. Through mutual agreement, the explosion limits should be rapidly lowered commensurate with the technical ability for verification, ultimately to achieve a comprehensive test ban agreement.

9. Negotiations should be renewed to ban any deployment of weapons in space or the testing of anti-satellite weapons.

10. U.S.-Soviet consultations should include the question of non-proliferation. Regional agreements involving nuclear-free zones should be encouraged.

In addition, President Ford and I agreed with many participants that to avoid the frustrating failure of the United States Government to ratify treaties that have been laboriously negotiated, the documents might be framed as executive agreements. These would require a majority vote in both houses of Congress, but would avoid the veto power of a mere one-third of the members of the Senate, many of whom are philosophically opposed to any reasonable agreement involving arms control, the Soviet Union, or international agencies.

There were other significant proposals that had support among all or a strong majority of those present, and these and the accompanying discussions were very valuable to all of those who attended the consultation. We will be preparing a more complete report of our sessions, and will send you a copy of it. I would welcome any comments you might have, including suggestions for similar consultations in the future.

With best wishes,

JIMMY.

Enclosure: List of participants.

THE CARTER CENTER OF EMORY UNIVERSITY, CONSULTATION ON INTERNATIONAL SECURITY AND ARMS CONTROL (APRIL 9–13, 1985); CO-CHAIRED BY PRESIDENTS JIMMY CARTER AND GERALD FORD

PARTICIPANTS

United States government officials and Members of the Congress:

Kenneth Adelman, Director, Arms Control and Disarmament Agency.

Norman Dicks (D.), Representative from Washington.

Thomas Downey (D.), Representative from New York.

Amoretta Hoeber, Principal Deputy Assistant Secretary of the Army for Research, Development and Acquisition.

Albert Gore, Jr. (D.), Senator from Tennessee.

John Lehman, Secretary of the Navy.

Sam Nunn (D.), Senator from Georgia.

Theodore Stevens (R.), Senator from Alaska.

Foreign government representatives:

China (People's Republic): Qian Jia-dong, Ambassador to the U.N. Conference on Disarmament, Geneva.

Egypt: Abdul Raouf El-Reedy, Ambassador.

Germany (West): Friedrich Ruth, Foreign Ministry Official Responsible for Questions of Disarmament and Arms Control.

Germany (East): Gerhardt Herder, Ambassador.

Great Britain: John Howe, Director, Arms Control Unit, Ministry of Defense.

Japan: Kinya Niiseki, Chairman of the Board of Directors, Japan Institute of International Affairs.

Pakistan: Agha Shahi, former Foreign Minister.

Soviet Union: Anatoly Dobrynin, Ambassador. Lt.-Gen. Konstantin Mikhailov, Ministry of Defense. Sergei Tarasenko, Deputy Chief, U.S.C. Department, Ministry of Foreign Affairs.

Former U.S. government officials and members of Congress:

Howard Baker, Senate Majority Leader; now a partner of Vinson & Elkins.

Harold Brown, Secretary of Defense; now Chairman of the Foreign Policy Institute of Johns Hopkins University.

Zbigniew Brzezinski, National Security Advisor; now Senior Advisor at the Georgetown University Center for Strategic and International Studies, and Professor of Government, Columbia University.

McGeorge Bundy, Special Assistant to the President for National Security; now professor of history, New York University.

Ralph Earle, Director, Arms Control and Disarmament Agency and Chief U.S. negotiator, SALT II; now managing partner, Baker & Daniels.

Raymond Garthoff, Ambassador to Bulgaria and SALT I negotiator; now Senior Fellow, the Brookings Institution.

William Hyland, member of the National Security Council staff; now editor of Foreign Affairs.

Adm. Bobby Inman, Director of the National Security Agency and Deputy Director of the Central Intelligence Agency; now President and Chief Executive Officer, Microelectronics and Computer Technology Corporation.

Gen. David Jones, (ret.), Chairman of the Joint Chiefs of Staff.

Henry Kissinger, National Security Advisor and Secretary of State; now Chairman, Kissinger Associates, Inc.

Gen. Edward Meyer, (ret.), Chief of Staff of the U.S. Army.

William Perry, Undersecretary of Defense for Research and Engineering; now managing partner, H&Q Technology Partners.

James Schlesinger, Secretary of Defense and Secretary of the Department of Energy; now Senior Advisor, Lehman Bros. Kuhn Loeb, Inc.

Brent Scowcroft, Assistant to the President for National Security Affairs and Chairman of the President's Commission on Strategic Forces; now Vice Chairman, Kissinger Associates, Inc.

Helmut Sonnenfeldt, member of the National Security Council staff; now Visiting Scholar, The Brookings Institution.

Cyrus, Vance, Secretary of State; now partner of Simpson, Thacher, and Bartlett.

Academic experts:

Desmond Ball, Senior Fellow and Deputy Head of the Strategic and Defense Studies Center, Australian National University.

Harold Berman, Woodruff Professor of Law, Emory University.

Richard Betts, Senior Fellow, The Brookings Institution.

Lynn Davis, Assistant Director, International Institute for Strategic Studies, London.

Karl Deutsch, Director, International Institute for Comparative Social Research, West Berlin.

Richard Garwin, IBM Fellow, Thomas J. Watson Research Center.

Arnold Horelick, Senior Political Scientist and Director of Soviet and East European Studies, the RAND Corporation.

Samuel Huntington, Professor of Government, Harvard University.

Josef Joffe, Senior Associate, Carnegie Endowment for International Peace.

Pierre Lellouche, Associate Director, Institut Francais des Relations Internationales, Paris.

Christopher Makins, Director, Institute of Security Programs, The Roosevelt Center for American Policy Studies.

Michael May, Associate Director-at-Large, Lawrence Livermore Laboratory.

Makoto Momoi, Director, The Momoi Research Institute, Tokyo.

Joseph Nye, Professor of International Affairs, Harvard University.

Robert O'Neill, Director, International Institute for Strategic Studies, Londong.

Dennis Ross, Executive Director, The Berkeley-Stanford Project on Soviet International Behavior.

Leonard Spector, Senior Associate, Carnegie Endowment for International Peace.

Kosta Tsipis, Senior Research Scientist, Massachusetts Institute of Technology.

Evgeny Velikhov, Deputy Director, Kurchatov Institute of Atomic Physcis and Vice-President, USSR Academy of Sciences.

Herbert York, Professor of Physics, Unviersity of California at San Diego.

Journalists:

John Grimond, American Editor, The Economist, London.

Flora Lewis, foreign affairs columnist, The New York Times.

Piero Ostellino, editor, Corriere della Sera, Milan.

APPENDIX 66

RESPONSES BY LYNN SYKES TO ADDITIONAL QUESTIONS SUBMITTED BY MINORITY MEMBERS OF THE SUBCOMMITTEE ON ARMS CONTROL, INTERNATIONAL SECURITY AND SCIENCE

Question. In regard to Comprehensive Test Ban (CTB) negotiations, Ambassador Stoessel said this before our Subcommittee, "I feel that uncertainties condemning verification technology, plus the Soviet record of violations make it inadvisable to proceed immediately to bilateral—or resumed trilateral with the United Kingdom—negotiations for a CTB with the Soviet Union." Given the record of Soviet non-compliance with arms control agreements, including the ABM agreement, the Soviet invasion Afghanistan, the Soviet shoot-down of the Korean airliner, and the Soviet killing of an American military officer, as well as persisting questions over verification technologies, why should this subcommittee approve H.J. Res. 3, which urges approval of the Threshold Test Ban Treaty (TTB) and the Peaceful Nuclear Explosion Treaty (PNET) and most importantly, instructs the President to immediately begin Comprehensive Test Ban (CTB) negotiations with the Soviets (after those very same CTB negotiations were cutoff with the Soviets by Jimmy Carter)?

Can you comment on these observations?

For what reasons, apart from Afghanistan, did the CTB negotiations break down under Jimmy Carter?

Answer. Uncertainties in verification technology and allegations of Soviet cheating on the Threshold Test Ban Treaty have been cited as important reasons for not continuing negotiations towards a Comprehensive Test Ban Treaty. I have argued in my testimony and prepared statement for the hearings of May 8 that during the last year the scientific community has come much closer to a consensus about the correct methodologies for estimating yields of Soviet explosions using seismological data. I have been part of a committee that has examined the question for the Defense Advance Research Projects Agency (DARPA). That panel and another panel formed by the Air Force Technical Applications Center have reviewed these questions extensively and in recent classified reports recommend the inclusion of yield estimates based on surface waves.

Although I and many others have long advocated the use of surface waves in addition to shorter-period body waves for yield estimation, the United States has relied in the past as it does today solely on body waves. The amplitudes of body waves are now universally acknowledged to vary strongly with the properties of the outer 100 miles beneath various testing areas. The case for Soviet cheating on the Treshold Treaty has evaporated as new techniques of seismic calibration have been tested and used and as new techniques of seismic calibration have been tested and used and as we have learned to calibrate the outer 100 miles of the materials beneath various sites. While by far the majority of scientific opinion indicates that the U.S.S.R. has been in compliance with the Treshold Treaty and has been observing a yield limitation, a small number of persons in DARPA and Los Alamos continue to insist on using old formulas for yield estimation which rely solely no body waves.

In his testimony Dr. Barker mentioned that there is non-seismological evidence for Soviet cheating on the Treshold Treaty. It has long been recognized that seismology provides the most accurate estimates of yield. Dr. Barker has chosen to cite a dubious and uncertain piece of evidence that has received very little discussion and review within the government or through review by external experts.

Question. Ambassador Stoessel, chief negotiator of the TTB and PNE, in testimony before our Subcommittee maintained that "on the technical side, there is continuing controversy regarding our ability to verify with sufficient accuracy the yields of nuclear explosions in the Soviet Union. While experts differ, many maintain that, without direct, on-site inspection, it is impossible to obtain adequate verification, and they hold that this would be the case even with the exchange of data provided for in the TTBT. They note, too, that these data are to be provided from each side's sources, and they claim that—given the record of Soviet violations as likely violations of arms control agreements—this is reason to question the reliability of such data."

Is this data exchange being made as provided by the TTB since both the U.S. and the Soviet Union have agreed to abide by the treaties though they are not ratified?

Has this data exchange procedure been fully resolved?

How can one tell if the data concerning calibration shots was correct?

Some believe it is necessary to obtain independently verified data that allows less ambiguous yield estimates for TTBT verification purposes. One specific U.S. proposal is for a direct yield measurement obtained by inserting a cable near the emplacement hole which would directly measure the explosion. In this regard, U.S. personnel would be required at Soviet test sites and Soviets would monitor U.S. tests. Can you comment on such a proposal?

Has the U.S. made any such proposals to the Soviets and if so, what has been the Soviet response. The June 3, 1983, edition of the Baltimore Sun reported that Lynn Sykes, of Columbia University, told the American Geophysical Union that the size of underground nuclear explosions at Soviet test sites could be determined with an uncertainty factor of 15–25% of the force of the blast. Yet many contend that the 150 kt level is difficult to verify, given the problems of Soviet compliance with the TTBT. Can you comment on these observations?

Answer. The accuracy of yield estimates for Soviet explosions is, of course, vital to ascertaining if the Soviet Union has complied with the terms of the Threshold Treaty. Very often general statements are made that yield either can or cannot be determined with sufficient accuracy. I have stated that yields of Soviet tests at their central Asian site (Shagan River), where the Soviets have conducted their largest tests since the TTBT took effect in 1976, can be determined with an accuracy of about 30%.

The upper half of the enclosed figure shows a histogram of numbers of explosions (vertical axis) as a function of their size, i.e., the seismic magnitude, m_b (horizontal axis). The figure shows that Soviet testing practice is to conduct large numbers of tests of a few specific sizes or yields, which are indicated by the sharp peaks in the diagram. If yields were as uncertain as Dr. Kerr and Dr. Baker maintain, those peaks would be much broader and not nearly as sharp as they are in the figure.

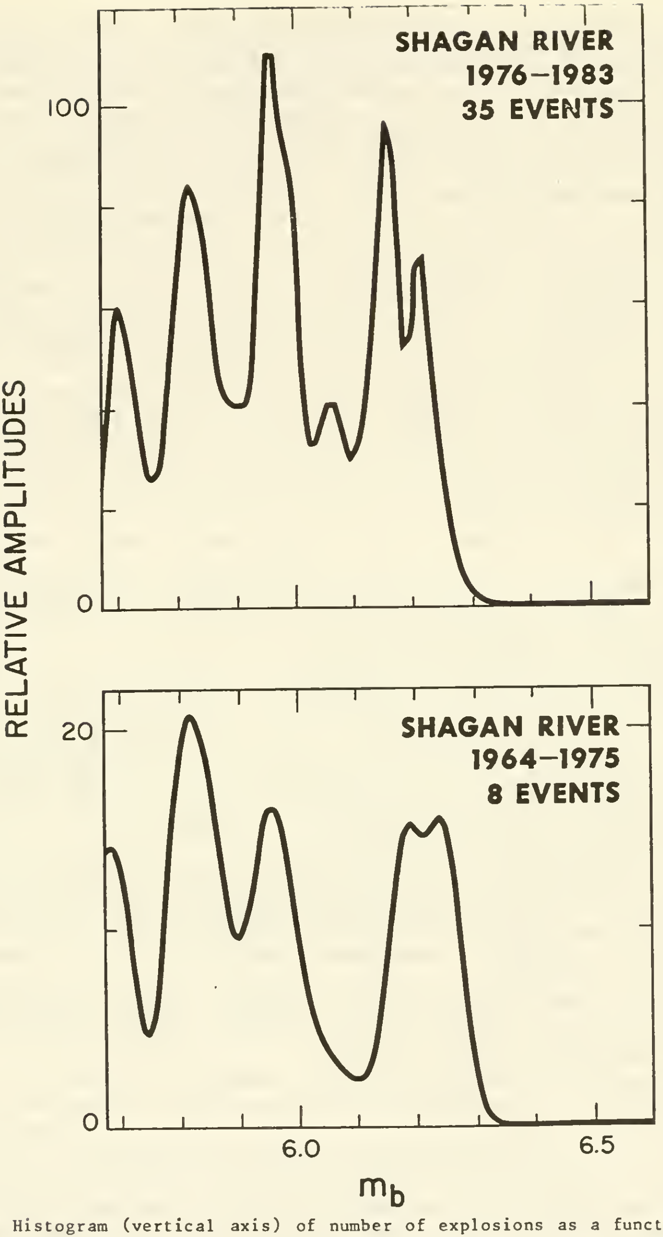


Figure 1. Histogram (vertical axis) of number of explosions as a function of their size (horizontal axis). m_b is the short-period seismic magnitude. Note that Soviet testing practice at the Shagan River testing area in Central Asia is to detonate many explosions of a few specific yields. The narrow width of the peaks indicates that Soviet testing practice at Shagan River, where the largest U.S.S.R. explosions have been detonated since 1976, is indicative of small uncertainty in yield.

In his testimony Dr. Kerr stated that he did not believe a 30% difference in yield, i.e., 195 vs. 150 kilotons, would be militarily significant but that a factor of 2 would be, i.e., a test like 300 kilotons. Let us assume that he is correct, and ask if the Soviet Union were to test an explosion of 300 kilotons, what is the chance that our monitoring systems would report it as being of a certain yield or greater? The 30% uncertainty that I have cited represents one standard deviation. If the yield of the explosion were 300 kilotons, there is an 84% chance that our systems would report it as having a yield greater than 230 kt, a 98% chance that it was of 178 kilotons or greater and a 99.6% chance that they would report it as larger than 150 kilotons.

A factor of two uncertainty has often been cited in conjunction with yield estimates. When one looks closely at reports and articles on the subject, one finds that that factor of two is not associated with one standard deviation but with two standard deviations, i.e., a 95% confidence level. Statistics have often been misused in portraying what is in fact a very high level of confidence as a likely probability. A factor of two associated with two standard deviations corresponds to a 41% variation in yield at one standard deviation. When that is compared with my estimate of 30%, the two estimates of uncertainty do not differ greatly.

Let us again ask the question if the Soviets test an explosion of 300 kilotons, what is the chance that U.S. systems will report the yield as greater than a certain amount if a factor two corresponds to two standard deviations? In that case there is a 84% chance that the yield will be reported as 212 kilotons or greater and a 98% chance that it will be reported as greater than 150 kilotons. In either case we arrive at a high probability that the U.S. systems will calculate a yield well in excess of 150 kilotons.

In the context with which we are dealing, sufficient accuracy, we need to ask what does it take to deter the Soviet Union from testing say 300 kilotons? I conclude that a 84% chance of the explosion being registered by U.S. systems as being at least as large as 212 or 230 kilotons respectively by the above two methods constitutes a sufficient deterent to the U.S.S.R. detonating explosions with yields of military significance in excess of 150 kilotons.

As mentioned in question 2, one specific U.S. proposal is for a direct yield measurement obtained by inserting a cable near the emplacement holes of U.S.S.R. explosions. That method probably would permit more accurate estimates of yield to be made. Nevertheless, we must ask what constitutes sufficient accuracy. During the negotiations for the TTBT and PNET from 1984 to 1986 seismologists informed U.S. officials of expected uncertainties in yields (either without the data package or if we were to assume it was reliable). At that time a factor of two uncertainty was considered politically acceptable by the Nixon and Ford administrations. In fact, estimates of yield have improved since that time.

What has changed since 1976 are demands for greater accuracy. Those demands have rarely been stated in other than vague terms. The question could be put: is an accuracy of 30% (or 41%) at one standard deviation sufficient to deter cheating of possible military significance? Dr. Kerr's statement about 300 vs. 150 kilotons indicates that it is sufficient without asking for additional verification measures or renegotiation of the TIBT.

The U.S. proposal for measurements at Soviet test sites is probably the most intrusive proposal that has been made for renegotiation for the Threshold Treaty. Like Dr. Hannon I think that other less intrusive requests would stand a better chance of being accepted by the U.S.S.R.

Question. Have the Soviets rejected all proposals concerning improved verification for TTBT? Why do you think the Soviets have refused to cooperate in improving upon verification of the TTBT?

While the U.S. is abiding by the 150Kt limit, under the TTB and PNE, The White House, in its arms control compliance reports to the Congress, has revealed U.S. concerns regarding Soviet compliance with the TTBT. The U.S. has judged that while ambiguities in the pattern of Soviet testing and verification continued in 1984, evidence available through the year confirms the finding that the Soviet nuclear testing activities for a number of tests constitute a likely violation of legal obligations under the TTBT, which bans underground nuclear tests with yields exceeding 150 kilotons.

Can you comment on the problems posed by the reported Soviet relations?

Answer. Already answered above.

Question. Verification capabilities assume an extremely important role in maintaining a Threshold Test Ban and Comprehensive Test Ban. On the question of verification, the Carter Administraton asserted that our national verification capabilities in the last twenty years have advanced to the point where we no longer have to rely on on-site inspection to distinguish between earthquakes and even very small weapon tests.

Do you believe that the U.S. now has the national technical means to enforce a TTB let alone a CTB, without on-site inspections?

What recommendations would you make to improve verification for the TTBT? How would you construct the verification provisions?

Answer. As stated above I believe the U.S. now has the national technical means to enforce a Threshold Treaty without on-site inspections. In that context I am assuming that on-site inspections would be allowed for peaceful explosions as specified in the Peaceful Explosions Treaty.

Similar reasoning can be applied to ascertaining if data on calibration shots given to us by the Soviet Union are correct. In fact, data on calibration explosions are not as vital now as they were deemed to be during the negotiations for the TTBT in 1974. At that time we did not have a good calibration of the various factors that effect the amplitudes of the short-period seismic waves that were used then (as they are used now) for yield estimates. We now have several seismic methods that give us consistent results on the calibration of short-period waves for the main Soviet test sites. In addition surface wave data and analyses have improved to the point in which they can be used for an accurate and independent calibration of yield.

The Threshold Test Ban Treaty also calls upon ratification for the exchange of geological and geophysical information about test sites. I conclude that those data will allow us to make qualitative improvements in the estimates of yield. As I stated in my testimony, we already have information about the geology of Soviet testing areas and abundant satellite photography of them. Those existing data allow us to make a number of important cross checks on the data package the Soviets would furnish us.

My views are similar to those in the letter sent to the Committee by Dr. Hannon of Lawrence Livermore. The geological and geophysical package is not an all-or-nothing thing that must be either completely accepted without reservation or completely rejected under the notion that none of its components can be checked. I believe reality is somewhere in between. Those aspects of the data package should allow us to make better estimates of the effects of the materials near explosions upon the sizes of seismic waves and hence allow us to calculate yield somewhat better than is now possible.

I recommend that on-site inspections, such as those of the challenge type, be a part of a Comprehensive Test Ban Treaty. Under a CTBT, however, it is more important that we have data from U.S. monitoring stations within the U.S.S.R. as was agreed to in the negotiations from 1977 to 1980. While seismological techniques for identifying underground weapons tests are highly reliable, they will not be 100% foolproof for explosions that are close to the lower limits of U.S. detection and identification systems. On-site inspections of the challenge type provide a means for the United States to demand access to the U.S.S.R. so as to verify if the signals from a small questionable event were those from an underground explosion or those generated by a small earthquake. Seismological identification has improved as much in the last 25 years that we no longer require the larger number of on-site inspections per year that the U.S. stated it did require in 1958 or 1963.

If the United States wishes to improve the verification of the Threshold Treaty we might ask the Soviet Union for various data that would allow us to calibrate the amplitudes of seismic waves in the Soviet Union more accurately. We might ask them, as an act of good faith, to turn over at least a portion of the geological, geophysical and calibration data prior to ratification. Another possibility would be to allow U.S. monitoring stations to operate for a period of time near the boundaries of their testing areas.

Question. Also, according to White House compliance reports, the Soviet Union has been sending radioactive nuclear debris across its borders for years in violation of the Limited Nuclear Ban Treaty. Can you comment on this matter?

Answer. It has been known for many years that both the U.S.S.R. and the United States have violated that item of the Limited Nuclear Ban Treaty of 1963 that prohibits radioactive nuclear debris from drifting across international borders. Neither country has violated the principal element of the 1963 treaty that forbids testing in the atmosphere, space or underwater. It is impossible to carry out large numbers of underground tests, as both the U.S. and the U.S.S.R., do without there being some probability that uncertainties in geology will cause some tests to leak into the atmosphere.

Question. An important assumption underlying the U.S. commitment to a Comprehensive Test Ban (CTB) has been that the CTB would affect stockpile confidence equally in East and West, and therefore not affect the strategic balance.

Can you comment upon this assumption?

What do you believe the Soviet Union would do under a CTB?

What do you believe the U.S. would do under a CTB?

Answer. This item is covered in my written testimony. Dr. Kerr and others have argued that the U.S.S.R. might be able to conduct very small tests that would not be identified under a Comprehensive Treaty that would be of military significance or would allow them to test the confidience of their stockpile. An alternative to a full or comprehensive test ban is a very low-yield threshold treaty, perhaps one with a yield limitation of about 1 kiloton. A low-yield treaty would allow both countries to conduct very small tests. It would not give the Soviet Union a possible asymmetric advantage if they tested at yields below the identification thresholds of our systems.

Question. Ambassador Stoessel told this Subcommittee that "given the persisting controversy over verification technologies and the evidence of Soviet non-compliance with a number of arms-control agreements, including the TTBT, I conclude that it would be desirable to provide for enhanced verification procedures in the TTBT and PNE agreements before they are ratified by the U.S. Senate.". . . Can comment on Ambasssador Stoessel's conclusion?

Answer. Answered under 2.

Question. Is verification the major issue delaying the CTB, or are there other important national security issues involved?

Answer. I have argued in my testimony and elsewhere that verification is not the major issue delaying a Comprehensive Test Ban.

Question. Some scientists and defense experts have argued that a CTB is not in the interest of the United States even if it would be perfectly verifiable, largely because our deterrent, including the defense of our allies, continues to rely on nuclear forces. Why do you believe the U.S. should sign an agreement which would result in the eventual erosion of our only real deterrent against any adversary?

How would the gradual and asymetrical loss of confidence in U.S. nuclear weapons deterrent under a CTB increase the pressure on some of our allies to provide for their own nuclear defense?

Answer. I strongly believe that the United States should only enter into agreements with the U.S.S.R. that are verifiable and equitable and that affect the performance of nuclear weapons of the two countries in a asymmetrical fashion. The wording of the question assumes that a CTBT would result in a gradual and symmetrical loss of confidence in U.S. nuclear weapons. A verifiable low-yield treaty would go far in assuring that any effects on force structure would be symmetrical.

If one is interested in the preservation of MAD, more is involved than the testing of weapons. The trend over the past 20 years since the signing of the Limited Test Ban has been in the direction of increased instability rather than stability. This has occurred as a result of the development of accurate, multiple warhead missiles, greater numbers of weapons that can be carried intercontinental distances and the shorter response times involved. If a full test ban treaty had been signed in 1963 or soon thereafter, I believe the United States and the Soviet Union would be far more secure than they are today. The development of many new weapons systems by both superpowers would have been stopped or greatly curtailed under a Comprehensive Test Ban. In addition, nearly everyone agrees that in 1963 the United States had a vast lead over the Soviet Union in delivery systems and in the number and variety of atomic weapons. At that time we were urged by opponents of a Comprehensive Test Ban to continue the testing of new nuclear weapons in the expectation that that would have a major impact on the strategic balance. In retrospect I think it is clear that the United States missed a great opportunity to freeze in or prolong for many years a commanding lead vis-a-vis the U.S.S.R.

Question. Many continue to support the concept of Mutual Assured Destruction (MAD) while opposing the President's Strategic Defense Initiative (SDI) which could result in Mutual Assumed Survival (MAS). If one is interested in the presevation of MAD, which involves the maintenance and even preservation of nuclear weapons for relative stability, why should we support a CTB which would not allow, for every long, the preservation of nuclear weapon through the primary mechanism of testing?

Answer. None.

Question. In our last hearing on this subject it was pointed out that the U.S. could simply take an old warhead off the shelf and place it on a new weapon system such as the Midgetman ICBM, yet Dr. Barker, in the August, 1983, edition of Physics Today you state that in every case to date, the replacement system (i.e. newer missile) has required a nuclear weapons different from that of the system it replaces. Can you and Dr. Kerr comment further on this matter?

Answer. None.

Question. Our national laboratories, for safety and security related reasons, have been in the process of incorporating insensitive high-explosive mixtures which can survive quite violent impacts in new nuclear weapons systems. Because the weapons with the new insensitive explosives are based on new designs that differ substantially from those using older explosives, testing plays a critical role in the conversion to safer nuclear weapons. How would a comprehensive test ban agreement impede conversion to "safer" nuclear weapons?

Answer. None.

Question. It has been pointed out by some scientists and defense experts that stockpile problems do occur, largely from metallurgical or mechanical problems, or from stricter standards of nuclear safety. How would a CTB impact upon our ability to improve the safety of our warheads and to confound terrorist activity, since newer and safer warheads would require testing?

Answer. None.

Question. In the normal course of events, a large data base is accumulated about nuclear weapons in the stockpile. To what extent would a data base, for the sake of performance and safety, of scheduled new weapons be affected by a comprehensive test ban?

Answer. None.

Question. Have the weapons in the U.S. stockpile been designed deliberately to survive under a prolonged CTB?

If they get sick and need repair, or rebuilding, can this be done with confidence after a long period without testing?

Is testing an essential part of the weapons technology program, or can the weapons technology be maintained by non-nuclear experiments and computer studies?

How does our past experience affect the answer?

Question. To what extent would a CTB complicate the conservation of scientific skills important to national security. (U.S. scientists and laboratories would eventually confine themselves to other tasks but the Soviet government can order scientists around.)

Answer. None.

Question. What position did the National Laboratory Directors take with regard to tests required to give continued assurance of weapon performance during a CTB of unlimited duration?

Answer. None.

Question. Before the CTB negotiations ended several years ago, the U.S., Great Britain and the U.S.S.R. agreed on the use of unmanned seismic stations which could be placed in a country to enforce a CTB. Can you comment on the problems, both positively and negatively, of the use of such seismic stations?

Answer. U.S. seismic listening posts in the Soviet Union would allow the United States to verify a Comprehensive Test Ban reliably down to explosions of smaller size than would be possible with external stations alone. Hence, I believe that the United States should continue to place great emphasis in negotiations on U.S. seismic stations within the U.S.S.R. Over the years the U.S.S.R. has shown greater flexibility in permitting seismic stations on its territory than they have with on-site inspections. I see no necessity for all U.S. stations to be either manned or unmanned. Unmanned systems that are tamper-proof and which transmit their data by satellite have been developed and tested.

Question. Was there an impasse involving the United Kingdom on the locations of so-called "black boxes" for seismic monitoring of a CTB?

Answer. I was not involved in the negotiations towards a CBTB in which this item was discussed.

Question. What is the level of yield at which we can now detect and identify nuclear tests and with what confidence?

Answer. I argue in my written testimony that with U.S. monitoring posts within the Soviet Union that a CTBT could be monitored with high reliability for yields of about 1 kiloton.

In the fall of 1983 an informal conference was held on the problem of verifying a CTBT or a low-yield threshold treaty. At the end the convenor asked the participants, who came from the Department of Defense, universities, the U.S. Geological Survey and the Lawrence Livermore Lab, what would be the lower limit of identification of U.S.S.R. explosions assuming the United States had a network of listening posts within the Soviet Union. Those who were questioned held a wide variety of beliefs about the desirability of a Comprehensive Test Ban Treaty. Nevertheless, the answers that they gave ranged from 1 to 5 kilotons.

At a symposium on verifying nuclear tests for the American Geophysical Union in the spring of 1983 a scientist from the Defense Advanced Research Projects

Agency, Dr. Thomas Bache, stated that the U.S.S.R. would be able to hide explosions of tens of kilotons even if the United States had large numbers of stations within the U.S.S.R. Dr. Hannon of the Lawrence Livermore Lab, another one of the speakers, was asked to comment upon that statement in view of his extensive calculations on network capabilities. He replied that there was no subsidence to the allegation that the Soviet Union could hide tens of kilotons clandestinely with U.S. monitoring posts in the U.S.S.R. I am not aware that Bache or other officials from DARPA, have published in either the open or classified literature any data or calculations to support that statement.

On page 12 of his written testimony Dr. Kerr makes a similar statement that tests of a few tens of kilotons could be conducted in violation of a total testing ban. It is widely recognized in the seismological community that the Los Alamos Lab that Dr. Kerr heads, while it is preeminent in the design of nuclear weapons, has very little capability in the area of seismological verification of a CTBT or TTBT. I am not aware that anyone from Los Alamos has published data that would argue the case that tens of kilotons can, in fact, be concealed under a CTBT.

The Lawrence Livermore Lab has a much greater number of seismological experts working on nuclear test detection and verification than does Los Alamos (by about a factor of 10 or 20). This is one of the reasons that I think that the positions taken by Dr. Kerr on the verification of the TTBT and a CTBT are in conflict with the views of the much larger and scientifically stronger seismological community at Livermore. I do not think that Dr. Kerr's views on those two questions stand serious scientific scrutiny.

Dr. Kerr stated that high-frequency seismology may hold promise for increasing the sensitivity of detection systems for decoupled tests but that this remains to be demonstrated. That capability is, in fact, greater than Dr. Kerr suggests. The one nuclear explosion that the United States detonated to test the decoupling theory showed that the amount of decoupling or muffling was not as great at high frequency (30 Hertz) as it was at those frequencies that are normally used to intercontinental monitoring. Those results were published by Drs. Healy, King and O'Neill of the U.S. Geological Survey in 1971. While the amount of muffling at high frequencies is still a significant factor, that test demonstrated that the effect at high frequencies, as predicted theoretically, is only 25% of that for waves detected at intercontinental distances. Norwegian seismologists using data from the NORSAR seismic array have shown that high-frequency waves are commonly detected for explosion of 1 kiloton or smaller for several parts of the U.S.S.R. Those effects were seen at a distance of several thousand miles from the explosions. While more work obviously remains to be done to quantify the capabilities of high-frequency monitoring, those data sets and theory are strongly indicative that high-frequency waves are a way of better detecting explosions detonated in large cavities.

Question. The September 8, 1983, edition of The Washington Post, reported that the Arms Control and Disarmament Agency, in a answer to written questions from the House Appropriations Committee, stated that a test ban could not itself end the threat posed by nuclear weapons, since it does not deal directly with the kinds, numbers, or deployment of nuclear forces. Can you comment on this observation?

Question. President Carter, in a September 29, 1977, news conference said "I recognize that progress on SALT leads to further progress on a comprehensive test ban." Do you believe that test bans and nuclear arms reductions are interdependent?

Do you believe that arms reductions in Geneva can lead to further progress on a comprehensive test ban?

Do you believe that test restrictions should be subordinate to progress on nuclear arms reductions?

Questions. Some believe that stopping nuclear testing will somehow reduce the possibilty of nuclear war?

Can you comment on this observation?

Answer. Here, I believe, is an area in which we are in agreement: that a test ban by itself would not end the threat posed by nuclear weapons. While I think that a Comprehensive Test Ban or a low-yield threshold treaty would be a very important arms control measure, it should not be thought that it alone would either end the arms race, reduce entirely the threat of nuclear weapons or usher in an era of disarmament. It would be a more modest measure. Nevertheless, if a CTBT were coupled with a ban on missile testing, cuts in offensive systems and limitations on weapons in space, the net effect of those agreements would have a major impact on the arms race. Of course, a CTBT by itself would not reduce the stockpiles of existing weapons.

Question. Mr. Barker, some argue if the U.S. and Soviet Union ceased testing, it would signal to other countries that we are serious about ending the arms race and nuclear proliferation. Yet you state in the August, 1983, edition of Physics Today that U.S. confidence in its nuclear detterent, which could be affected by a CTB, would also have international implications. Can you comment on the impact that a CTB may have on our friends and allies?

Answer. None.

Question. Dr. Sykes, in a statement to this Committee, said that a CTB could be verified down to one kiloton. Moreover, Dr. Sykes maintains that politics—not technology—prevents us from concluding a comprehensive test ban.

Can you comment on this observation?

Answer. None.

Question. Dr. Sykes, in an article entitled the "Verification of a Comprehensive Nuclear Test Ban" which appeared in the October, 1982, edition of Scientific American, you stated that we are certain that the state of knowledge of seismology and the techniques for monitoring seismic waves are sufficient to ensure that a feasible seismic network could soon detect a clandestine underground testing program involving explosions as small as one kiloton. What do you mean by the words "feasible" and "could soon detect"?

Can the other witnesses comment upon whether a test ban can be detected down to one kiloton?

Answer. None.

Question. This Subcommittee has received testimony from Dr. Willard J. Hannon, Program Manager of the Seismic Monitoring Research Program at Lawrence Livermore National Laboratory, who concluded that the current assessments of the relationships among yield seismic magnitude and the pattern of Soviet testing at their Shagan River test site indicate that the Soviets are observing a yield limit in their testing program which is consistent with TTBT compliance. Yet, in the January, 1985, edition of Science magazine, Dr. Hannon states that the lack of in-country Soviet explosion data seriously limits U.S. confidence in its ability to identify smally seismic events and that the size of the Soviet Union and operational and security considerations provide many possible sites for clandestine testing. Moreover, he states that seismic verification of a CTB will not ensure identification of all underground explosions. Can you comment on these observations?

Answer. None.

APPENDIX 67

Responses by Donald Kerr to Additional Questions Submitted by Chairman Fascell

1. I cannot fully concur with the conclusions of my distinguished colleagues. It is true that disassembly and inspection of the components of nuclear weapons, including their firing and fuzying equipment, are essential for maintenance of the stockpile. Indeed, we presently conduct regularly scheduled random sampling, in which we do disassemble and inspect nuclear weapons. However important, this procedure is not enough. When irregularities are found--as they are, from time to time--they are referred to the experts at the weapons design laboratories for their judgment as to the severity of the problem and the necessary "fix." The solution is often one that can be validated on the basis of previous research and development tests related to the system in question, or to related systems. These fixes can be made without a new nuclear test. In cases where such validation is not possible, we occasionally decide that an additional test is required if the weapon is to be retained in the active inventory. In all such cases, without the test or tests required, certification of the weapon, at least as we have known it until now, would be impossible.

2. We have sometimes heard it said that a CTB in the 1960s would have prevented the development of multiple, independently targetable re-entry vehicles (MIRVs) by the U.S. and the USSR. There is no way to know if this is true. The key to MIRVs is the ability to maneuver a vehicle from one precise location in space to another. The ability to make the maneuvers necessary to send nuclear warheads to individual targets was developed by the U.S. and the USSR in their space programs.

   To take advantage of MIRV technology, it is necessary to carry more than one nuclear weapon per missile. This could be accomplished in several ways: by building larger missiles; by taking a previously developed nuclear warhead off the shelf (if one was available); or by developing smaller, lighter nuclear warheads. Only the last possibility would have been affected by a CTB. The imposition of a CTB, then, would not necessarily have prevented MIRVing. Moreover, under a CTB, the USSR might have been better situated than the U.S. to proceed with MIRVs because of their tendency to build large missiles.

3. Nuclear testing allows the US to continue to depend upon nuclear weapons for deterrence and defense. Our nuclear test program is essential in designing, engineering, manufacturing, maintaining, and certifying nuclear weapons. Nuclear tests are essential for determining the proper functioning of nuclear explosives. Calculations do not suffice, and there is no way experimentally to simulate the total performance of a nuclear weapon. Further, the US nuclear weapons laboratories have maintained for years that testing programs are essential in maintaining the nuclear weapons capability of the nation. Without an experimental testing program, we would expect the technical experience and capability of the nation to erode substantially.

Against the national security benefits of continued nuclear testing, CTB proponents argue that a CTB would prevent the development of new generations of nuclear weapons--which are generally viewed on inherently more dangerous, destructive and destabilizing. However, precisely the opposite has been the case: testing has been and continues to be necessary for reducing the damages and distructiveness of nuclear weapons.

CTB, proponents offer two other asserted benefits, which are primarily political in nature. First, it is frequently suggested or asserted that a carefully negotiated, binding, and fully verifiable CTB could be the breakthrough that would result in genuine arms control through reductions in nuclear arsenals. However, even the staunchest proponents of a comprehensive test ban have recognized that a CTB will not by itself end the arms race; and will not result in a reduction of nuclear weapons, and their decommissioning and dismantlement. Many of the same obstacles that have prevented significant nuclear arms reductions also stand in the way of agreeing to a CTB. If a way could be found to overcome those obstacles, it would probably best serve our arms control objectives to move directly to the negotiations of strategic and theater nuclear arms reduction agreements.

It is also questionable whether a CTB would significantly improve the non-proliferation regime, as proponents suggest. From a technical point of view a comprehensive test ban has only a marginal effect on the proliferation of nuclear weapons. Testing is not essential for designing and building the simple, first generation fission devices that a would-be proliferator is likely to want at the beginning of a nuclear weapons program.

It is also argued that a non-discriminatory comprehensive test ban, signed by nuclear and non-nuclear weapon states alike, would inhibit the spread of nuclear weapons by making tests of nuclear explosives politically more costly than they already are. In the view of CTB proponents, conclusion of a comprehensive test ban treaty would demonstrate the United States' commitment to fulfill its obligations under Article VI of the NPT. And, with the NPT Review Conference approaching later this year, they argue that movement toward a CTB would prevent further erosion of support for the NPT and increase the attractiveness of the Treaty for "holdout" states.

While a CTB might--and I stress "might"--have marginal, short-term benefits for the NPT, it is unlikely to have a significant long-term effect on the problem of proliferation and the strength of the non-proliferation regime. It is unlikely that the states interested in building nuclear weapons are driven primarily by the "bad example" of the major powers. Thus, a comprehensive test ban is unlikely to prevent a country from deciding to develop nuclear weapons if it believes it can and should do so. Nor would it be likely to meet the goals of the non-nuclear-weapon states by bringing about general and complete disarmament or ending the distinction between the nuclear and non-nuclear-weapon states.

All in all, the real and known technical costs of a CTB appear more compelling than anticipated political benefits. It is certain that we must continue to test if we intend as a nation to rely upon nuclear forces in our defense posture, as we expect to do for the foreseeable future.

APPENDIX 68

Responses by Donald Kerr to Additional Questions Submitted by Minority Members of the Subcommittee on Arms Control, International Security and Science

1. I would argue that verification should be a crucial consideration in any decision on the nuclear testing restraints discussed in H. J. Res. 3. And, it seems to me, this means that we will have to consider not only the verification techniques and technologies available, but also the record of Soviet compliance with past and present arms control agreements. We are working to improve existing verification technologies, and to develop new ones, and have identified several promising avenues of research for reducing uncertainties about Soviet compliance with current and future testing restraints. But concerns about possible Soviet treaty violations exacerbate the uncertainties of current and prospective verification technologies. Because of doubts about Soviet behavior, verification requirements must be more stringent than might otherwise have been the case. This, I believe, was Ambassador Stoessel's point when he told the Subcommittee that it was inadvisable to proceed immediately to CTB negotiations.

When the CTB negotiations ended there were many unresolved technical issues. Indeed, negotiations had reached an impasse on the scope and duration of the Treaty, as well as on several key verification provisions. Among the latter was the question of in-country "black box" monitors. In order to meet Soviet demands, the US scaled down its requirement to a number well below that originally considered necessary by the technical experts. The Soviets accepted the lower number, but insisted the same number should be placed on UK territory. However, the UK refused to consider more than two or three stations on its territory. In spite of major US concessions, other verification issues were also unresolved, including the means of authenticating and transmitting essential data. Another related issue involved the basis for requesting an "invitation" to make an on-site inspection. The Soviets wanted this to be done solely on the basis of seismic observations, the inadequacy of which was the reason for needing on-site inspections in the first place. The US wanted no restrictions placed on requesting an invitation.

2. In a protocol to the TTBT, the parties agreed to exchange geological and geophysical data simultaneously with the exchange of instruments of ratification. Consequently, the data exchange provisions of the TTBT have not yet come into effect, and we do not know how valuable these data would be. It is by no means certain, as some would have us believe, that the exchange of these data upon ratification of the TTBT will reduce ambiguities about the size of Soviet tests, or that it will increase confidence in Soviet compliance with the provision of the TTBT. However, any possible reduction of uncertainty that might result from data exchanges and calibration shots specified in the Protocol to the TTBT would depend, in part, on our confidence in the accuracy and completeness of the data provided by the Soviets. Since the Treaty does not provide for confirmation of the data supplied, we would have to trust the Soviets on this vital matter to a far greater degree than we have in other areas.

The data exchange procedure has not been fully resolved. A major impasse appears to involve the differing concepts of geophysically distinct testing areas. Yet, these are of critical importance to verification, because the geophysical characteristics of an area are necessary to interpret the signals emanating from a seismic event in that area. There is no way to confirm Soviet designation of such areas within their test sites. Nor is there any possible way to demonstrate whether the data on calibration shots is correct.

An on-site but non-intrusive verification technique called CORRTEX (a hydrodynamic shock measurement) has been developed and used by Los Alamos National Laboratory for measurement of nuclear test yields. Providing a direct and much more accurate estimate of yield than any remote technique, it appears especially promising. If application of this technique were allowed, it could provide much improved confidence that the Soviet Union was abiding by the terms of the TTBT. In addition, this method could help resolve some of the major uncertainties and ambiguities in remote monitoring data, by providing a continuous flow of calibration measurements on nuclear test events. This technique could be used to respond to President Reagan's call, in his September 1984 speech to the General Assembly of the United Nations, for an exchange of experts at the nuclear test sites of the US and the USSR who would directly measure nuclear test yields.

3. I cannot answer to whether the Soviets have rejected all US proposals to discuss improved verification for the TTBT, or to possible Soviet motivations.

4. I do not know whether the Soviet Union is violating the TTBT. It has on occasion been suggested in public that Los Alamos believes that the Soviets have violated the 150 kt limit, while Livermore disagrees. Los Alamos has analyzed seismic data statistically, using models believed to be consistent with official positions and actions. We concluded on the basis of this data that the issue of Soviet compliance is unresolved and, with the methods of remote seismic verification that are presently available, unresolvable.

In brief, we have identified two plausible "models" of the Soviet test program since 1979. They are equally consistent with the pattern of seismic signals, and there is no way even theoretically to decide between them. One model, known as "testing to a limit," assumes the Soviets have imposed some upper limit to the size of their tests. As we now infer yields from seismic signals, that limit is still about 40 percent higher than the threshold. However, the technical community is now considering another "bias" adjustment that would reduce the apparent limit to 150 kt. In that case the seismic signals would be consistent with Soviet compliance, according to this particular model. The other model, known as the "flier," is equally plausible. In this model, the Soviets test only occasionally at yields above the limit, but when they do, the tests are well above the limit. No bias change that has been proposed will eliminate the possibility of violations with potential military significance under this model.

As I have said, either model is equally plausible from a statistical point of view. The problem involves uncertainties in measurement (encompassing both the nature of seismic measurement and the amount and accuracy of available data) and the difficulties of translating these uncertainties into high-confidence conclusions about compliance.

5. I do not believe the United States now has the national technical means to verify compliance with a TTBT, yet alone a CTB, without on-site inspections. As I have indicated, adequate TTBT verification without on-site verification of the kind proposed by the President Reagan is currently not possible; with on-site measurements with an accuracy in the range provided by CORRTEX, verification would probably be adequate. On the other hand, on-site inspection is necessary for CTB verification but it is not sufficient. Significantly improved remote monitoring devices would also have to be developed and probably deployed in large numbers in the Soviet Union to reduce the risk of clandestine tests going undetected.

6. The signatory nations have complied with the LTBT prohibition on atmospheric and under water testing since the treaty was signed (although France and the People's Republic of China, which are not signatories, continued testing above ground). But the Treaty's prohibitions on the release of radioactivity across national boundaries as a result of testing has become a bone of contention between the United States and the Soviet Union. Venting of radioactive material from Soviet tests has been detected on numerous occasions. A Soviet test in 1984, for example, prompted a US demarche at the ambassadorial level. The military significance of such a violation is not obvious, but the possibility of Soviet violations highlights the need for future treaties to be verifiable, and to include appropriate sanctions for detected non-compliance.

7. The assumption that a CTB would affect stockpile confidence equally in East and West is not demonstrable. Since we do not know the specifics of Soviet nuclear weapon design, we are unable to say whether they would be affected by a CTB in the same manner and to the same extent that we would be. It is by no means certain that a CTB would prevent the Soviets from developing a new generation of nuclear weapons. Equally important, it is quite possible that the Soviet military nuclear technology base and most of their nuclear stockpile could be preserved and maintained indefinitely with tests of a few tens of kilotons in violation of a total testing ban. These options are not open to the US, and the effect on the strategic balance of resulting asymmetries would be profoundly destabilizing.

I do not know how the Soviets would actually behave under a CTB but, as I indicated, if they chose not to comply fully with a total testing ban they could conceivably maintain their current stockpile and even introduce a new generation of nuclear weapons. There is no question in my mind on how the US would behave under a CTB--we would observe it scrupulously.

8. The United States continues to observe the TTBT but, in order to reduce concern about potential military disadvantages to the United States, I would urge improved verifiability. We would then have greater confidence that the Soviets were subject to symmetrical restrictions. Whether or not improved verification methods should be agreed to before ratification of the Treaty is a political decision to be taken by the President and Congress.

9. Professor Sykes's view is well-known to the panel of experts that determines official US policy on this matter. The panel does not agree. To support his conclusions, Sykes invokes high-frequency seismic data, the utility of which has not been demonstrated for yield estimation.

The figures widely used in public discussions of TTBT verification is that the US can achieve an uncertainty factor of about two (2). Using these figures, the Soviets could fire as much as three times the TTBT limit, or 450 kt, before we would have high assurance that we would report a violation. If they only fired at twice the threshold, the odds would be even that we would even raise a question about their test, and if we did they could easily deny that they violated the limit.

10. The limitations of current verification technologies argue eloquently against a CTB at the present time. Current problems do not mean that a comprehensive test ban will remain unverifiable forever, and at Los Alamos and elsewhere work on several promising new technologies for verification is being undertaken. Yet, even with monitors on Soviet soil and on-site inspections, verification of a CTB in the foreseeable future would involve uncertainties.

Even if the solution to formidable verification problems were in our grasp, as some argue, I could not now support a CTB. The effect of a CTB on the national security mission of the Laboratory and the DOE nuclear weapons complex would be devastating. A CTB would lead to a loss of confidence in the reliability of our nuclear weapons and would result in substantial erosion of our capability to design, manufacture and maintain nuclear weapons. A CTB would effectively preclude responsible and desirable modernization of the nuclear stockpile, and prevent desirable risk-free improvements to enhance the safety, efficiency, economy and extended reliability of our nuclear weapons. As long as we depend upon nuclear weapons for deterrence and, ultimately, defense, these consequences are highly undesirable.

11. We know that we would eventually lose confidence in our nuclear deterrent under a CTB. We cannot anticipate whether the loss would be gradual or rather more dramatic and immediate. We cannot assume that the Soviet stockpile would be equally affected by a CTB; indeed, we think it quite possible it would not be.

In light of these concerns, the strategic situation would probably be very unclear and potentially unstable. Loss of confidence in our deterrent would raise fundamental questions about extended deterrence. One result could be the development of nuclear capabilities by our allies in Europe and Asia. It is normally not recognized that the US nuclear umbrella, provided through security treaties like NATO, has certainly been one of the most effective non-proliferation tools ever developed.

12. Whether one wishes to rely on the situation known as mutual assured destruction (MAD), or hopes eventually to move through the deployment of more and more effective strategic defenses to a situation that has been labeled mutual assured survival (MAS), it is clear that we will continue to depend on nuclear weapons for the foreseeable future. If it is decided, for political or technical reasons, that we should continue to rely exclusively or primarily on offensive nuclear forces, we will need to test to assure our deterrent's reliability, and to allow us to modernize the deterrent to make sure it is survivable and contributes to stability. If we are to explore the full range of technologies for strategic defenses to assess the contributions they could make toward deterrence and to a defense-dominant world, or if we merely wish to take prudent steps to protect our deterrent against a possible Soviet deployment of a nationwide ballistic missile defense system, a CTB would be very damaging. A CTB would halt virtually all research on nuclear concepts for strategic defenses. It also removes the capability to evaluate the vulnerability of our stockpile to nuclear ABM systems as deployed by the Soviet Union. In general, a CTB would greatly constrain attempts to find a defense against ballistic missiles that has the robustness one would desire.

13. The US could probably use one of several warheads that have already been developed, tested, and deployed on other weapon systems for a new weapon such as the "Midgetman". Yet, as Dr. Barker has testified, this is inconsistent with past practice, and there are good reasons why we would prefer not to do so in the future. An existing warhead would not

be optimized for the new delivery system. In the case of Midgetman, where Congress has defined some system specifications, the penalties for using an existing warhead might be especially acute. The main penalty, which would probably be a lower yield for the warhead, might mean that the weapon system would not be able to carry out some of the missions for which it was intended or could be used.

14. The incorporation of insensitive high explosives into weapons designs does require testing. Indeed, without testing we could not incorporate into warhead designs many other features to improve safety and security. An experience during the 1958-61 testing moratorium is illustrative. At that time, we made safety-related changes in a stockpile weapon, with full confidence in those changes. When testing was resumed, and the weapons were tested, it failed.

15. As I indicated, those changes necessary to improve safety and security of nuclear weapons need to be confirmed by testing. We are justly proud of the excellent safety and security record of our weapons. But, as Dr. Barker indicated in testimony before the Subcommittee on May 8, 1985, as new technologies that could make these weapons even safer and more secure become available, who would take it upon themselves not to attempt to incorporate those changes into weapon designs?

16. In 1978, the weapons laboratories did a study for the Senate Armed Services Committee that documented what we have recognized for many years: once a weapon is in the stockpile, we accumulate a large data base on the performance of the weapon itself and of its components. In the first place, there is very intensive surveillance of the weapon, during which we look for signs of possible deterioration. When irregularities are found, they are referred to the design experts most familiar with the weapons for decisions about what must be done. Most problems are resolved without testing, many times on the basis of the

designers' recent experience with similar problems in the continuing test program. Occasionally a test is required, but again a test in the continuing program may serve the purpose.

Second, although we occasionally take a weapon from stockpile and test it just to reaffirm that it works as certified, it is rarely necessary to do so. In the normal course of events, as we reported to the Committee, the weapons, or key parts of them such as the primaries, will be taken from the stockpile and fired for some purpose other than a confidence or "proof" test. For example, many stockpile weapons or primaries have been used in what are called "effects tests," done mostly by the Defense Nuclear Agency for their own purposes. We participate in all such tests and carefully observe their results.

As a consequence, virtually all of the weapons introduced in the stockpile prior to the last few years have been fired, some of them repeatedly, for any of several reasons. A large data base does exist for these weapons. The most recent additions to the stockpile, those in the last five years or so, have not yet had the full benefit of this kind of testing, and the data base for these weapons is relatively small. A CTB would prevent a more extensive data base from coming into existence.

17. The laboratories have always designed as much reliability and longevity into the US weapons as possible, given the state of knowledge and materials technology at any given time. However, the weapons in the US stockpile have not been designed with a prolonged CTB in mind. And, over an extended period of time, our confidence in the reliability of current stockpile weapons would decline without the benefit of testing. We believe that it may be possible to design a so-called "wooden weapon," and we have undertaken some preliminary design studies. It must be realized, however, that the characteristics of such weapons might well be very different from those of today, because their longevity would have to be assured even in the absence of a nuclear design technology base. And weapons of this type would almost certainly require extensive and very expensive revisions of existing weapon delivery systems.

Unless and until we develop wooden weapons, testing will be required if weapons have problems and need to be repaired or rebuilt. As well, nuclear tests are essential for designing new weapons. Calculations do not suffice to determine the proper functioning of nuclear explosives, and there is no way experimentally to simulate the total performance of a nuclear weapon. Without testing, we might occasionally stockpile new designs or inadequately reasoned changes in old ones.

18. The US nuclear weapons laboratories have maintained for years that testing programs are essential in maintaining the nuclear weapons capability of the nation. This position is based on our experience during the test moratorium. Without an experimental testing program, which challenges our nuclear weapon designers and tests their designs, we lost our best designers. Those remaining were not be able to demonstrate the validity of their theories. In effect, if there were no testing over a period of years, we would expect the technical base of knowledge and experience required for developing and maintaining weapons to dissipate and disappear.

19. On advice from the weapons laboratory directors, I testified before Congress in 1978 as acting Assistant Secretary for Defense Programs in the Department of Energy, that testing at 3 to 5 kilotons would be necessary under a CTB of unlimited duration. The directors argued that, under a treaty of unlimited duration, tests would be required at this level of yield to give continued assurance of weapon performance. They argued that at this level we could maintain some of the essential technology base, and correct some, but not all, recognized stockpile problems as they developed. For a treaty of limited duration--three to five years--the stockpile might be reliable without such tests or it might not. It was considered impossible to predict.

A review of this issue in my present position has led me to conclude that this limit may be dangerously low. To be sure, using remote teleseismic monitoring, undisguised, coupled nuclear tests in hard rock can probably be detected down to a few kilotons. However, by testing inside a hollow cavity, hiding tests in ground motion from earthquakes, and the like, an extensive test program involving occasional tests at a few tens of kilotons could be conducted without detection by remote teleseismic monitors. By adding on-site monitors and improving remote monitoring techniques, our ability to detect such tests may be improved. But, without such improvements, I do not believe that we can with reasonable assurance enforce a test ban below a few tens of kilotons. I believe that both laboratories now would agree that this somewhat higher limit is necessary for the purpose of assuring weapon performance. Even with a threshold at this level, some elements of the stockpile might eventually be in jeopardy.

20. The number of stations agreed to, as I already have indicated, it was significantly smaller than the number our experts then considered necessary. Interestingly, the differences between the number of stations then agreed to, and the numbers cited recently in certain optimistic projections of our capability to verify compliance with a CTB is even more significant. In addition, the Soviets insisted on specifying the locations for such stations, which therefore might not be optimized for enforcement of a CTB. The location of stations at carefully chosen low noise sites is a key part of the more optimistic recent assessments. Moreover, in the CTB negotiations the US proposal for prompt and authenticated data transmission was rejected by the Soviets.

21. The Soviet demand for the UK to accept as many "black boxes" as the US and USSR, and in locations where British sovereignty was in dispute (e.g., the Falkland Islands), was unacceptable to the British. As I indicated, the UK refused to consider more than two of three stations on UK territory.

22. In my opinion, the best answer to this question is still that given by a UK representative to the Geneva Disarmament Commission. He argued that "some tens of kilotons" is the level at which we could enforce Soviet compliance with a CTB. I know of no development in the verification field which would lead me to alter this estimate.

23. I am in full agreement with the reported ACDA statement. A CTB could not itself end the problem posed by the deployed nuclear warheads on both sides; it does not deal directly with the kinds, numbers, or deployment of nuclear forces. To focus on a CTB as the goal of arms control policy seems to me to work the wrong side of the problem. I cannot believe that a CTB can be a substitute for real nuclear arms control. Indeed, as Ambassador Stoessel suggested in testimony before this Subcommittee in February, the complete cessation of nuclear weapon testing is entirely rational only in an environment in which our dependence on nuclear weapons is reduced by agreements which successfully achieve substantial reductions of deployed nuclear weapons, and perhaps also by some level of non-nuclear defenses.

24. Yes, I believe that nuclear test bans and nuclear (as well as conventional) arms reductions are interdependent. A test ban, in my view, should be contingent upon significant reductions of nuclear and conventional arms. Unless this is the case, a CTB would pose serious dangers for US national security. I hope that the negotiations in Geneva will achieve substantial cuts in the offensive nuclear forces of the United States and the Soviet Union. If the talks are successful, we will have taken a major step towards creating the conditions in which our long-standing commitment to a CTB can be realized without unduly jeopardizing US national security interests.

25. I do not understand the logic of those who argue that stopping nuclear testing will somehow reduce the possibility of nuclear war. Indeed, a premature ban on nuclear testing could easily have the opposite effect by introducing significant instability into the US-Soviet

strategic relationship. I share the hope of avoiding nuclear war expressed in this argument, but I cannot share the faith in the use of a comprehensive test ban to achieve this end.

26. The US nuclear deterrent does not only provide protection to the US. Through security treaties such as NATO, that protection is extended to our allies. The level of confidence we have in our nuclear deterrent has implications for our willingness to carry out our commitments to defend our allies. This fact is not lost on them, as the public debate on the credibility of extended deterrence over the last decades has suggested. If a CTB diminishes US confidence in the deterrent, as it would surely do, it would diminish our allies confidence in the extended deterrent. Our alliance system, so painstakingly built in the postwar world and so important to the preservation of freedom and democracy in the world, would be undermined. Allies might develop their own nuclear capabilities, or if they are unable or unwilling to do so, they might be unable to defend themselves and to resist Soviet political and military pressures.

27. As I have indicated, I do not believe current verification technologies are adequate to verify compliance with a CTB. However, even if verification technologies were considerably improved, I could not recommend entering into a CTB. My reasoning is based solely on national security considerations. In light of our dependence on nuclear weapons for deterrence and defense--a dependence which derives from the international political situation, and particularly our adversarial relationship with the Soviet Union--we must continue to test.

28. I have indicated that I believe that the lower limit at which we can enforce a CTB is several tens of kilotons. All experts agree that there is some lower limit below which nuclear tests in hard rock cannot be detected with remote seismic monitors; the usual figures cited are one, two, or a few kilotons. But it is possible to disguise tests of relatively large nuclear weapons by exploding a device inside a hollow

underground cavity, by hiding explosions in earthquakes, or by using shock-mitigating materials. A militarily significant nuclear test program in this way could be unrecognized by a network of remote teleseismic monitoring stations. Further, a CTB could require a much more extensive monitoring network than now exists, because we would have to protect against the possibility of a violator conducting tests clandestinely underwater, in the atmosphere, and in outer space, as well as underground.

29. Concerning Dr. Hannon's testimony on Soviet compliance with the 150 kt limit of the TTBT, I find myself unable to conclude that the Soviets are observing the Treaty's yield limit on the basis of seismic data alone. But, neither can I conclude that they are in violation of that limit. The problem, as I see it, is that the data are not inconsistent with either conclusion. Thus, as I hope I have made clear, the issue of Soviet compliance with the TTBT is not resolvable using known remote seismic monitoring methods.

With respect to Dr. Hannon's remarks on verifying compliance with a CTB, which poses quite a different problem than TTBT verification, I am in general agreement. We would indeed have problems in identifying small seismic events in the Soviet Union, and the possibility of undetected Soviet clandestine tests could not be precluded.

APPENDIX 69

Letter From Lawrence Livermore and Los Alamos National Laboratories Responding to Questions From Representative Henry J. Hyde

June 7, 1985

Congressman Henry J. Hyde
U. S. House of Representatives
2104 Rayburn House Office BUilding
Washington, D.C. 20515

Dear Congressman Hyde:

We appreciate your writing us in regard to House Joint Resolution 3 and are pleased to provide the following replies to your questions. We have attempted to keep our comments unclassified, but to give full details in answering your questions, we have sent a separate classified addendum to our response.

--- * ---

Question: Is continued nuclear testing necessary to ensure the reliability of the nuclear weapons in the U.S. stockpile?

Answer: Continued nuclear testing is absolutely essential to ensure the reliability of our nuclear weapons. As Directors, we have the responsibility to certify that weapons designed at our Laboratories will function when and if they are ever needed. Our deterrent depends upon nuclear testing and the Soviets know this.

Nuclear weapons are complex mechanisms, and of necessity, are made of highly reactive materials. Because of these inherent characteristics, it has been found over the years that changes have occurred in stockpile weapons which brought to question whether a weapon would perform as designed. Today we have procedures which can identify and correct these faults as they occur. These procedures rely on skilled personnel and on some occasions the need to carry out nuclear tests. Under a CTB, we would lose our skills and expertise. Weapon design experts would inevitably leave the weapons program because they could not verify their theoretical ideas with experiments. Those who stayed would gradually lose their sharpness, and new workers would never have the opportunity to gain experience.

For the last 15 years the Soviets have undertaken an extensive modernization program, while our nuclear deterrent force has aged. Our forces are in need of modernization for improvements in safety, security, survivability, and effectiveness. A CTBT would prevent these needed improvements and would lock in asymmetries that have developed between us and the Soviets. A CTBT would severely impact the development of new weapon systems vital to our national security.

--- * ---

LLNL • Defense Systems, L-20 • P.O. Box 808 Livermore, California 94550 • Telephone (415)423-6806 • FTS 523-6806

Question: Is it true that reliability can best be determined by disassembling sample weapons and subjecting the components to non-nuclear tests?

Answer: The maintenance of confidence in the reliability of our weapon stockpile consists of the stockpile surveillance program, the quality assurance and reliability testing of non-nuclear components, and the nuclear testing of warhead components or related nuclear devices in the on-going nuclear weapon development program. While non-nuclear quality assurance/reliability testing sometimes detects problems with the nuclear component of warheads, the most serious stockpile problems are only revealed and solved by nuclear tests.

As noted by Messrs. Bethe et al, we cannot statistically monitor the nuclear performance of the stockpile. This makes the nuclear tests we do perform all the more important. We regularly do production-verification nuclear proof tests and randomly pull units from important systems in the stockpile to verify their continued proper performance. Mainly, we use the continuing nuclear test program to confirm the design choices made in stockpiled weapons. Nuclear tests have identified design problems and unanticipated effects of aging which dramatically affected performance of certain devices, in some instances affecting a large fraction of the stockpile. Major unexpected vulnerabilities were also revealed and safety was found to be reduced.

An example of a stockpile problem that was revealed by a nuclear test involved the W45 warhead. The W45, which was used in the Little John missile and then in the Terrier missile and the atomic demolition munition (ADM), was developed in part during the 1958-1961 test moratorium. When the W45 was tested after the moratorium with certain small changes to simulate the effects of aging in the stockpile, the result was a rude surprise: the test device gave only half its rated yield. More recent examples of problems that have been revealed by nuclear tests are given in the classified addendum to this letter.

Many stockpile problems which have been identified, whether by nuclear or non-nuclear tests, have required nuclear tests to guarantee a final design. Alternatives would have involved unacceptable reductions in yield and reliability or unacceptable operational limitations.

With respect to remanufacture, even if it were determined in principle to be the best fix, experience has taught us that it is literally impossible to prevent changes in materials and workmanship quality and standards, or even specifications and working drawings, over an extended period of time. We have no way of knowing the impact of subtle changes in manufacturing practices, without performing a nuclear proof test to gain the confidence that the effects of seemimgly harmless process changes were properly addressed. In addition, since we do not have a "first principles" understanding of nuclear weapon physics, we may not be able to control all the correct specifications. Thus it is imperative to test the effects of changes. The examples discussed in the classified addendum illustrate the ways in which testing substitutes for a lack of first principles understanding.

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Question: Would the United States have high confidence in its nuclear stockpile without nuclear testing?

Answer: We do not believe that the U.S. could maintain high confidence in its nuclear stockpile without nuclear testing. As long as our national security interests depend on the deterrence of war with nuclear forces, a CTBT is not in our national interest. Weapons technology plays an important role in guaranteeing the viability of our deterrent, and the ability to test nuclear weapons is a crucial aspect of that technology.

Our answers to your first two questions explain why past and current problems dictate the need for nuclear testing to maintain confidence in our stockpile. In the past, even our most experienced weapon designers have been surprised when pressed to make what were thought to be minor changes to stockpile systems. In the future, we can virtually guarantee that similar design changes will arise, changes that are dictated by safety considerations, use of new materials, new configurations, or military requirements. Not all such changes would require certification by a full scale nuclear test, but all rely on data obtained in nuclear tests and, most critically, on the judgment and insight that scientists and engineers acquire on the basis of such data. Under a CTB, experimental data would no longer be obtained from testing, and the pool of experienced specialists would decline.

--- * ---

Question: List some specific consequences of our maintaining an "unreliable stockpile" -- including but not limited to safety considerations.

Answer: We have no doubt that a CTB would lead to the loss of expertise and in turn to the loss in the reliability and confidence in our nuclear weapon systems and deterrent capability. Whether these considerations would apply to the Soviets, we do not know. There are arguments on both sides of the issue. But either way, taking a path which could lead to grave doubts about the reliability of our deterrent would be a prescription for political instability, and possibily, disaster. This appears to us to be the most serious consequence of an unreliable stockpile.

In regard to political instability, we have an open society, and it would be impossible to hide for long any diminished confidence that might develop with the stockpile. We believe that the situation would be quite different for the Soviets who have a closed society. This is just one example of an asymmetry that would exist under a CTBT.

Another asymmetry would develop if the Soviets were to circumvent a CTBT. Contrary to what some scientists have been saying, those of us familiar with verification technology know that our ability to monitor a CTBT is currently insufficient to prevent the Soviets from carrying out occasional clandestine underground tests up to 10 kt, and tests in deep space to much higher yields. This would lead to an asymmetry in stockpile confidence that would favor the Soviets. In addition, if the Soviets continued to test and we did not, their nuclear design and testing capability would remain significantly more viable than ours.

General Comment: A CTBT is an incomplete form of arms control. It would limit only one part of the equation. It drastically inhibits development of the nuclear weapon itself, while there is progress in other aspects of Soviet weapon systems, such as increased accuracy of missiles, expansion of ABM capabilities, further improvements in air defenses, and potential improvements in antisubmarine capability. The last two developments affect what are generally acknowledged to be our most stabilizing second-strike weapons systems.

Again, thank you for soliciting our response on this vital question of nuclear testing limitations. It is to your credit that you have done so, and we hope the rest of your colleagues will also benefit by considering more than just a limited input on the issue.

Sincerely,

Roger E. Batzel
Roger E. Batzel, Director
Lawrence Livermore National Laboratory

Robert N. Thorn
Robert N. Thorn, Deputy Director
Los Alamos National Laboratory

Dr. Robert Thorn, Deputy Director of Los Alamos National Laboratory, signed this response on behalf of Dr. Kerr who is en route to Europe.

APPENDIX 70

Letter From Richard Garwin, IBM Watson Research Center to Chairman Fascell in Response to the Lawrence Livermore and Los Alamos National Laboratories Letter to Representative Henry J. Hyde

July 23, 1985

The Honorable Dante B. Fascell
Chairman
House Foreign Affairs Committee
Attention: Ms. Janey Wright
2103 Rayburn House Office Building,
Washington, DC 20515

Dear Chairman Fascell:

I write in response to the joint letter of Roger E. Batzel and Donald M. Kerr, of 06/07/85. Their statement "Continued nuclear testing is absolutely essential to ensure the reliability of our nuclear weapons" is inconsistent with the position that I have taken (together with my colleagues) in our letter of 05/14/85.

I wish to point out to you that it is also inconsistent with the position taken for several years in the mid-1970s by Dr. Harold M. Agnew, at that time Director of the Los Alamos National Laboratory. It was Dr. Agnew's firm position that nuclear testing was *not* necessary to ensure stockpile viability, but that he needed only an adequate budget for non-nuclear testing, together with the use of the national-security exemption provided by the Occupational Safety and Health regulations. When Dr. Agnew later changed his position, I believe it was on the basis that the Congress and successive Administrations would not provide the needed budget and attention to stockpile reliability in the absence of nuclear testing.

If, indeed, Drs. Batzel and Kerr (like the more recent position of Dr. Agnew) are making the *political* judgment that the absence of nuclear testing would likely lead to inadequate budgets and attention to nuclear weapons reliability, then they should say that explicitly. I believe that one should stick to the strictly *technical* aspects of the question of the necessity of nuclear explosion testing to ensure stockpile reliability, to have the broadest possible scope for political decision in this matter.

You might wish to solicit Dr. Agnew's views on this technical question, as embodied in his former position on this topic.

Sincerely yours,

Richard L. Garwin

Also Adjunct Professor of Physics at Columbia University
(Views not necessarily those of IBM or Columbia)

APPENDIX 71

RESPONSES BY ACDA TO ADDITIONAL QUESTIONS SUBMITTED BY CHAIRMAN FASCELL FOLLOWING THE MAY 8 MARKUP

Q27. In the FY 1986, Arms Control Impact Statements and in other testimony, the Administration asserts that a CTB is a long-term goal of this Administration.

Without dictating the parameters of the negotiations, H.J. Res. 3 simply calls on the President to propose to the Soviet Union the immediate resumption of negotiations on a verifiable CTB.

-- In this light, would not the H.J. Res. 3 be in keeping with the Administration's long-term objective of negotiating a CTB?

A. The immediate resumption of CTB negotiations would imply that conditions are ripe for conclusion of a treaty, an implication that is unwarranted based on our current reliance on a nuclear deterrent and the existence of serious verification problems. A CTB nevertheless remains a long-term goal of US policy in the context of broad, deep and verifiable arms reductions, maintenance of a credible nuclear deterrent, improved verification capabilities, and expanded confidence-building measures.

Q28. Would you agree with the following statement?: "if we go ahead and ratify and then work to improve the verification... we will demonstrate that when the United States puts its good name on the line for a treaty of this significance, it can be counted on to follow through."

(This statement was made by David Emery in his confirmation hearings in 1983.)

A. The Threshold Test Ban Treaty cannot now be effectively verified. Verification must be substantially improved before the President could in good faith determine that the Threshold Test Ban Treaty is in the interest of our national security and before he could thus seek the advice and consent of the Senate to its ratification. The US has sought to discuss the development of such improved verification procedures with the Soviet Union, but the Soviets have thus far rejected such discussions.

Q29. The Senate last year in a 77-22 vote, urged the President to attach his verification concerns to the Threshold Test Ban Treaty and the Peaceful Nuclear Explosions Treaty when he seeks their ratification.

-- Does this not accommodate those who are concerned that verification issues be further addressed. Does this not, in fact, lay the groundwork for discussions with the Soviets on verification issues, subsequent to ratification of the treaties?

A. The groundwork for discussions with the Soviets on verification issues has been laid on numerous occasions when the Administration has sought to engage the USSR in discussions on verification improvements for the TTBT and PNET. In addition, in his address to the United Nations General Assembly on September 24, 1984, President Reagan proposed an exchange of visits to allow Soviet experts to come to the US nuclear test site and US experts to go to a Soviet nuclear test site to measure directly the yields of nuclear weapon tests. Our verification concerns cannot be satisfied by appending them to requests to the Senate for advice and consent on treaty ratification. They can only be satisfied by an honest exchange of technical views with the Soviets on how verification can be improved and subsequent negotiation with them about the means which will permit effective verification. Ratification without such verification improvements would provide no guarantee of their subsequent adoption. Moreover, attaching US verification concerns or unilateral conditions to the twin accords prior to ratification could evoke Soviet charges of bad faith. We want to fix the treaty before, not after we ratify. Failure to do so will only fuel future acrimony.

Q30. In Article 6 of the Non-Proliferation Treaty of 1968, the US and the Soviet Union pledged their commitment to pursue negotiations to bring an end to the nuclear arms race.

-- Is it not the case that if the Congress were to pass H.J. Res. 3, the Senate ratified the two testing treaties and negotiations between the US and the Soviet Union resumed on a comprehensive test ban treaty, that this would strengthen our commitment to the Non-Proliferation Treaty and signal the developing countries that we are serious about bringing an end to nuclear testing?

A. Ratification of the Threshold Test Ban Treaty, The Peaceful Nuclear Explosions Treaty and the resumption of negotiations on a

Comprehensive Test Ban Treaty would do nothing to eliminate the distinction between nuclear weapon states and non-nuclear weapon states . Only the radical reductions and ultimate elimination of nuclear weapons can achieve that goal. The US has placed priority on those negotiations which have this as that objective. Moreover, ratification of the two threshold treaties in their current form could signal that the US is not serious about its compliance concerns or its insistence on effective verification.

Q31. In April, DARPA's seismic review panel (made up of university seismologists) completed a classified report on yield estimation. It is my understanding that the panel's recommendations, if implemented, would go far in correcting past methods of estimating yield that resulted in Administration concerns about possible Soviet violations of the TTBT.

-- What is the status of this study? Why has it not been released? What can you tell the committee about the contents of the study?

A. In February 1985, DARPA convened a Technical Review Panel of seismologists to consider questions related to the best procedures for using surface waves to estimate yields of large Soviet nuclear tests. The Panel met twice in February and worked individually in March and April. Its classified report was forwarded to DARPA by the panel chairman on May 13, 1985. It has not been released because it is currently being reviewed by the DOD technical working group on verification.

The report deals with the question of more reliable yield estimates based on surface-wave data. Application of new techniques to the full set of data recorded from large Soviet nuclear tests since 1976 would take some time. However, due to our lack of direct knowledge, this new approach would still not be free of assumptions or judgments about the geophysical environments of Soviet nuclear test sites. The DARPA Study does not take into account the totality of evidence available for the estimation of Soviet yields, as current work intends to do. (Also see next question.)

Q32. It has also come to my attention that AFTAC (the Air Force

Technical Applications Center) has completed a study on yield estimation.

- -- What is the status of this study? Why has it not been released?

- -- What can you tell the committee about the contents of the study?

A. AFTAC convened a technical review panel in March 1985 to evaluate seismic R&D and formulate, based solely upon consideration of seismic issues, a recommendation to the DCI on yield-estimation formulas. The panel's classified study is complete and has been provided to the DCI.

The report deals with the question of more reliable yield estimates. The report recommends that the current seismic yield estimation procedures be revised.

Application of new techniques to the full set of data recorded from large Soviet nuclear tests since 1976 would take some time. However, due to our lack of direct knowledge, this new approach would still not be free of assumptions or judgments about the geophysical environments of Soviet nuclear test sites. The AFTAC report does not take into account the totality of evidence available for the estimation of Soviet yields, as current work intends to do.

Q33. Is it correct that you worked on verification at the Lawrence Livermore Lab?

- -- Do all or most seismologists at Livermore who are familiar with problems of verification agree with the overall conclusion stated by Dr. Hannon of Livermore in his April 29, letter to Chairman Fascell in which he says:

  > " the Soviets are observing a yield limit in their testing program. Our best estimates of this limit are consistent with TTBT (Threshold Test Ban Treaty) compliance."

- -- Do you agree or have any reasons to doubt that point of view?

- -- Do most US seismologists familiar with verification agree with Dr. Hannon's point of view?

A. Yes, I represented the Director of Lawrence Livermore National Laboratory on arms control issues during 1982 and 1983.

Dr. Hannon's communication to Chairman Fascell of April 29, 1985, states that the views expressed are his own. I have no information on the views of other seismologists at Livermore. It is very important to note that Dr. Hannon's letter also states: "However, seismic signals vary due to inhomogeneities in the Earth and extrapolation of experience at the United States test site to the estimation of Soviet yields involves some uncertainty. As a result, the available data cannot preclude the possibility that some of the Soviet tests may have been greater than 150 kilotons". (Emphasis added.)

The views of prominent US seismologists are routinely sought on the subject of seismic verification by seeking their participation in expert review panels. These views are fully considered in determining the process by which the US estimates the yield of Soviet nuclear tests. Additional classified analysis and intelligence information, not generally available to seismologists, also have a bearing on the yield estimation problem.

Q34. Did you attend the symposium on "Verifying Nuclear Test Bans" by the American Geophysical Union in the Spring of 1983?

The overwhelming consensus of the seismologists at the symposium was that the Soviets have not violated the TTBT.

-- What is your reaction to this?

A. No, I did not attend the symposium. However, other Administration officials did attend. It is inaccurate to characterize the view of the overwhelming consensus of the seismologists at the symposium as being that the Soviets have not violated the Threshold Test Ban Treaty.

There was no vote by the symposium attendees, nor other procedure to determine whether there was a "consensus" on anything. Nor was there any attempt to present enough information at the symposium to allow a judgment on the question of whether the Soviets have violated the TTBT, nor to resolve the conflicting pieces of evidence and problems exposed at the symposium. The actual classified data and analyses -- both seismic and nonseismic -- used by the government in assessing

TTBT compliance were not presented. The purpose of the symposium was to educate a wider audience on one aspect of the test ban treaty verification problem and the scientific issues involved. It is our view that the symposium helped in this regard.

Q35. Are the yield estimates that the Government makes for Soviet explosions under review?

A. Yes. The methodology for estimating nuclear test yields, and the estimates themselves, are periodically reviewed .

Q36. What would happen if the Administration found out that the yields it has been getting were substantially wrong -- that they should be lower?

A. The Administration periodically reviews its yield-estimating methodology, and the estimates of the yields themselves. Moreover, the Administration periodically re-evaluates its conclusions on Soviet noncompliance with the 150-kt threshold. Should any changes be necessary they will be made.

Q37. Is there agreement within the Government on the present official method of estimating Soviet yields?

- Who agrees and who disagrees?
- Where does the Joint Atomic Energy Intelligence Committee stand on this issue?
- How much is ACDA spending on seismic verification and why has this amount declined since 1970, if verification is our principal concern?

A. There is agreement within the government that present methods of estimating Soviet yields are not adequate to verify the TTBT effectively and that effective verification measures must be negotiated with the Soviet Union. The present official method of estimating Soviet yields is in use throughout the US government. There is reason to believe that it should be

> reviewed; a comprehensive review is underway. There has been a vigorous research effort to improve the methodology for estimating the yields of Soviet nuclear explosions. As a result of this effort, there has been an increase in the understanding of the phenomenology relating to the radiation of seismic energy from underground nuclear explosions. However, we must take into account the totality of evidence available for the estimation of Soviet yields, as current work intends to do.

While the Administration reviews these issues it would be inappropriate to be more specific about its internal deliberations.

JAEIC uses the present official method for reporting estimates of Soviet yields. This method is currently under review.

ACDA is not and has not been the major USG sponsor of seismic verification research which is funded principally by DARPA and DOE. ACDA contributions to seismic verification research have varied over the years depending on research requirements as indicated in the following chart:

Year	External Research ($1000)
1970	25
1971	none
1972	100
1973	225
1974	none
1975	35
1976	178
1977	54
1978	279
1979	394
1980	750
1981	440
1982	330
1983	160
1984	120*

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* In 1984 there was an additional $99,000 in DARPA funds managed by ACDA.

This year ACDA is providing administrative and technical management of DARPA sponsored seismic verification projects in the amount of $375,000.

DARPA has the responsibility within the DOD for supporting research efforts aimed at improving the verification of nuclear test ban treaties. Funds for this support come from two Program Elements:

- PE 62714E Nuclear Monitoring
- PE 61101E Defense Research Sciences (Geophysical Research)

The funding profile for nuclear test ban verification research is given in the following table.

Fiscal Year	Amount ($M)	Comment
86	14.7	Requested in FY 86 DOD Submission to Congress.
85	14.0	Reduced $2.0M by Congress from DOD request.
84	14.9	
83	15.7	
82	17.8	
81	15.5	
80	11.6	
79	9.3	
78	10.0	
77	11.5	
76	10.0	
75	9.6	
74	11.1	
73	12.9	
72	16.6*	
71	19.4*	
70	27.3*	

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* Includes funding for completion of VELA Satellite Program for detecting atmospheric explosions for Diamond Dust/Diamond Mine nuclear tests for energy quenching experiments.

Research on the verification of nuclear testing limitations continues to be of paramount importance. The large funding in 1970-1973 included support for two large demonstration projects: VELA satellites which demonstrated the capabilities for detecting nuclear explosions in the atmosphere and experiments to examine the possibility of absorbing the radiated energy of nuclear explosions to reduce the detectability. Efforts in the past several years have concentrated in these areas: (1) demonstrating key verification tools for potential use in a CTB; (2) supporting the technical aspects of our multilateral activities on test bans such as the work to develop and demonstrate an International Data Exchange System by the Geneva Conference on Disarmament; and (3) improving our technical capabilities to verify the Threshold Test Ban Treaty. An attempt was made to increase the funding for this effort for FY 1985 and beyond, but the Program Element for Nuclear Monitoring was reduced in the Congressional appropriation.

Q20. Before the CTB negotiations ended several years ago, the US, Great Britain, and the USSR agreed on the use of unmanned seismic stations which could be placed in a country to enforce a CTB. Can you comment on the problems, both positively and negatively, of the use of such seismic stations?

A. [security deletion]

Q21. Was there an impasse involving the United Kingdom on the location of so-called "black boxes" for seismic monitoring of a CTB?

A. [security deletion]

Q22. What is the level of yield at which we can now detect and identify nuclear tests and with what confidence?

A. [security deletion]

APPENDIX 72

RESPONSES BY ACDA TO ADDITIONAL QUESTIONS SUBMITTED BY MINORITY MEMBERS FOLLOWING THE MAY 8 MARKUP

Q1. In regard to Comprehensive Test Ban (CTB) negotiations, Ambassador Stoessel said this before our Subcommittee, "I feel that uncertainties concerning verification technology, plus the Soviet record of violations make it inadvisable to proceed immediately to bilateral -- or resumed trilateral with the United Kingdom -- negotiations for a CTB with the Soviet Union." Given the record of Soviet non-compliance with arms control agreements, including the ABM agreement, the Soviet invasion of Afghanistan, the Soviet shoot-down of the Korean airliner, and the Soviet killing of an American military officer, as well as persisting questions over verification technologies, why should this subcommittee approve H.J. Res. 3, which urges approval of the Threshold Test Ban Treaty (TTBT) and the Peaceful Nuclear Explosion Treaty (PNET) and most importantly, instructs the President to immediately begin Comprehensive Test Ban (CTB) negotiations with the Soviets (after those very same CTB negotiations were cut off with the Soviets by Jimmy Carter)?

-- Can you comment on these observations?

-- For what reasons, apart from Afghanistan, did the CTB negotiations break down under Jimmy Carter?

A. The Administration opposes the passage of H.J. Res 3. A CTB continues to be a long-term objective of US arms control policy, but in the context of broad, deep and verifiable arms reductions, expanded confidence building measures, maintenance of a credible nuclear deterrent and improved verification capabilities. In addition to serious verification problems, there continue to be significant concerns about the other national security implications of a CTB. The security of the US and our Allies depends on a credible nuclear deterrent, and nuclear testing plays an essential role in ensuring a credible US deterrent, particularly in view of the massive buildup of Soviet nuclear forces. For these reasons, the US does not intend to pursue negotiations toward a CTB at this time.

As for the TTBT and PNET, these treaties are not effectively verifiable in their present forms. Hence, the administration will continue to seek ways in which we can correct the serious verification problems. It is not in our security interests to ratify the twin accords without improved verification measures; and without resolution of our concerns about Soviet compliance with the TTBT. The Soviets' refusal to discuss either subject, as well as our concerns about a CTB, make H.J. Res. 3 unacceptable.

The trilateral CTB talks recessed in November, 1980, at the end of the fall negotiating round. Since the US Presidential election had just occurred, no date was set for their resumption, in order to allow the new Administration to formulate its policy on a CTB. For the reasons just mentioned, the new administration decided not to pursue a CTB in the near term, and announced its policy in July, 1982.

Q2. Ambassador Stoessel, chief negotiator of the TTB and PNE, in testimony before our Subcommittee maintained that "on the technical side, there is continuing controversy regarding our ability to verify with sufficient accuracy the yields of nuclear explosions in the Soviet Union. While experts differ, many maintain that, without direct, on-site inspection, it is impossible to obtain adequate verification, and they hold that this would be the case even with the exchange of data provided for in the TTBT. They note, too, that these data are to be provided from each side's sources, and they claim that--given the record of Soviet violations and likely violations of arms control agreements--this is reason to question the reliability of such data."

-- Is this data exchange being made as provided by the TTB since both the US and the Soviet Union have agreed to abide by the treaties though they are not ratified?

-- Has this data exchange procedure been fully resolved?

-- How can one tell if the data concerning calibration shots were correct?

-- Some believe it is necessary to obtain independently verified data that allow less ambiguous yield estimates for TTBT verification purposes. One specific US proposal is for a direct yield measurement obtained by inserting a cable near the emplacement hole which would directly measure the explosion. In this regard, US personnel would be required at Soviet test sites and Soviets would monitor US tests. Can you comment on such a proposal?

-- Has the US made any such proposals to the Soviets and if so, what has been the Soviet response?

A. The importance of the data exchange provisions of the TTBT has been overstated. While the exchange was intended to reduce

> the uncertainty associated with TTBT verification, there is no assurance of monitoring improvements since, as mentioned in Ambassador Stoessel's testimony, there is no provision for independent validation of the data to be exchanged.

No data have been exchanged under Treaty provisions. (Under international law, parties to an unratified treaty are obligated only to refrain from actions that would defeat the object and purpose of the accord.) Both the US and USSR have stated their intentions to abide by the 150-kiloton TTBT threshold, but this political commitment does not extend to the data exchange. In fact, the USSR declined a 1979 US suggestion for a limited trial data exchange similar to that envisoned for the TTBT.

In President Reagan's address last September to the UN General Assembly, he proposed that the US and USSR find a way for Soviet experts to come to the United States nuclear test site, and for ours to go to theirs, to measure directly the yields of nuclear weapon tests. Thus, the US fully supports the principle of direct on-site yield measurement. The insertion of a cable in a drilled hole near the nuclear device emplacement hole is a proven method of direct yield measurement. Unfortunately, the Soviets have commented negatively in public on the President's initiative and have ignored it in diplomatic channels.

Q3. Have the Soviets rejected all proposals concerning improved verification for TTBT? Why do you think the Soviets have refused to cooperate in improving upon verification of the TTBT?

A. The Soviets have rejected all our proposals to meet and confer on verification improvements. While they have not responded officially to the President's 1984 initiative in this field at the UN General Assembly, the Soviets have reacted negatively in public statements.

One can only speculate on exactly what Soviet motivations are in refusing to accommodate our concerns; a number of different factors likely contributed to their position.

Q4. While the US is abiding by the 150 kt limit under the TTB and PNE, the White House, in its arms control compliance reports to the Congress, has revealed US concerns regarding Soviet compliance with the TTBT. The US has judged that, while ambiguities in the pattern of Soviet testing and verification continued in 1984, evidence available through the year confirms the finding that the Soviet nuclear testing activities for a number of tests constitute a likely violation of legal obligations under the TTBT, which bans underground nuclear tests with yields exceeding 150 kilotons.

-- Can you comment on the problems posed by the reported Soviet violations?

A. The role of high-yield warheads in Soviet military planning may provide the USSR with incentive to test above the 150-kiloton TTBT limit. The uncertainties in the US determination of Soviet test yields provide the opportunity. However, the US is unable to evaluate the degree of any such exploitation. Unilateral and asymmetric observance of any arms control measure by the US could lead to significant military advantages for the USSR.

Q5. Verification capabilities assume an extremely important role in maintaining a Threshold Test Ban and Comprehensive Test Ban. On the question of verification, the Carter Administration asserted that our national verification capabilities in the last twenty years have advanced to the point where we no longer have to rely on on-site inspection to distinguish between earthquakes and even very small weapon tests.

-- Do you believe that the US now has the national technical means to enforce a TTB let alone a CTB, without on-site inspections?

-- What recommendations would you make to improve verification for the TTBT?

-- How would you construct the verification provisions of a CTB agreement?

A. The USG, after extensive review and analysis, has determined that the TTBT is not effectively verifiable in its present form. One factor which currently limits our ability to effectively verify compliance with the 150-kiloton TTBT threshold is the lack of direct and verifiable calibration information about the Soviet nuclear test sites, including information about the geophysical conditions under which the tests are carried out. The information to be exchanged upon ratification under the terms of the data exchange protocol of the current treaty would be somewhat helpful but clearly not definitive in this regard without independent validation of its accuracy.

In September, 1984, at the UN General Assembly, President Reagan proposed that the US and USSR to find a way for Soviet experts to come to the United States nuclear test site and for ours to go to theirs to measure directly the yields of tests of nuclear weapons. His hope was that such an exchange would begin to lay the basis for verification of effective limits on underground testing. The USSR has commented negatively in public on the President's offer, but has never formally responded in diplomatic channels. Soviet acceptance of the invitation would represent an important first step in this field.

Verification of a CTB must address monitoring in all environments, not just underground. The Administration continues to support active research in this field in keeping with its continued support for a CTB as a long-term goal of US arms control policy. However, the US does not now have the means to effectively verify compliance with a CTB.

Q6. Also, according to White House compliance reports, the Soviet Union has been sending radioactive nuclear debris across its borders for years in violation of the Limited Nuclear Test Ban Treaty. Can you comment on this matter?

A. The LTBT specifically prohibits nuclear explosions in the atmosphere, in outer space, and under water. It also prohibits nuclear explosions in any other environment "if such explosion causes radioactive debris to be present outside the territorial limits of the State under whose jurisdiction or control such explosion is conducted." The President's unclassified 1985 Report to the Congress on Soviet Noncompliance with Arms Control Agreements concluded that the Soviet Union's underground nuclear test practices have resulted in ventings which have caused radioactive matter to be present outside the Soviet Union's territorial limits in violation of its legal obligation under the Limited Test Ban Treaty. The Soviet Union has failed to take the precautions necessary to minimize the contamination of man's evnironment by radioactive substances. These ventings have continued despite repeated US requests for corrective action.

Q7. An important assumption underlying the US commitment to a Comprehensive Test Ban (CTB) has been that the CTB would affect stockpile confidence equally in East and West, and therefore not affect the strategic balance.

-- Can you comment upon this assumption?

-- What do you believe the Soviet Union would do under a CTB?

-- What do you believe the US would do under a CTB?

A. The assumption that stockpile confidence would erode equally in East and West, and therefore would not affect the strategic balance, is without merit. Three comparative factors must be considered -- weapon design technology, skill of the personnel retained in the weapons programs, and an actual stop to testing. We do not know whether US and Soviet nuclear design philosophies and capabilities are the same. Even if they were the same, stockpile problems would not occur simultaneously and equally in the two national stockpiles. Additionally, the nature of the Soviet society and government would permit the Soviet Union to keep its most skilled technical people in the weapons program, whereas many US experts would leave for more professionally active fields, as we discovered during the 1958-61 moratorium on nuclear testing. Much US confidence is derived from inspection and non-nuclear testing of various components. Without the underlying expertise gained from nuclear testing, even this could become difficult or impossible. Finally, the Soviets might attempt to answer some stockpile confidence questions by testing, if they were confident in escaping detection or were certain of the inability of the US to prove a violation had occured.

Q8. Ambassador Stoessel told this Subcommitttee that "given the persisting controversy over verification technologies and the evidence of Soviet noncompliance with a number of arms-control agreements, including the TTBT, I conclude that it would be desirable to provide for enhanced verification procedures in the TTBT and PNE agreements before they are ratified by the US Senate."

-- Can you comment on Ambassador Stoessel's conclusion?

A. The Administration has concluded it is essential that improved verification procedures for the TTBT and PNET be agreed prior to ratification, and has repeatedly sought to engage the USSR in developing such improved procedures. US leverage to obtain changes and Soviet incentive to agree would disappear after US ratification. Ratification would bring no assurance of improvements in our ability to monitor the threshold limits, improvements which the US believes are necessary for effective verification.

Q9. The June 3, 1983, edition of the Baltimore Sun reported that Lynn Sykes, of Columbia University, told the American Geophysical Union that the size of underground nuclear explosions at Soviet test sites could be determined with an uncertainty factor of 15-25% of the force of the blast. Yet many contend that the 150 kt level is difficult to verify, given the problems of Soviet compliance with the TTBT. Can you comment on these observations?

A. Our reaction to this reported statement is to wonder whether Professor Sykes was misquoted: we know from experience at NTS that we cannot confidently estimate the yields of US tests to anywhere near this 15-25% accuracy with high confidence using any generally applicable teleseismic magnitude-versus-yield relationship. But it is a fact that on occasion, as was recently in one case, that teleseismic techniques are quite accurate. No seismic research group advising the US Government has ever supported such a low uncertainty factor for teleseismic estimates of Soviet yields.

Q10. Is verification the major issue delaying the CTB, or are there other important national security issues involved?

A. A number of important national security issues are involved. The Administration has concluded that a comprehensive test ban remains a long-term objective of the United States, within the context of broad, deep and verifiable arms reductions, maintenance of a credible nuclear deterrent, expanded confidence-building measures, and improved verification capabilities. There is much to be accomplished with respect to each of these objectives.

Q11. Some scientists and defense experts have argued that a CTB is not in the interest of the United States even if it would be perfectly verifiable, largely because our deterrent, including the defense of our allies, continues to rely on nuclear forces. Why do you believe the US should sign an agreement which would result in the eventual erosion of our only real deterrent against any adversary?

-- How would the gradual and asymmetrical loss of confidence in US nuclear weapons deterrent under a CTB increase the pressure on some of our allies to provide for their own nuclear defense?

A. These are indeed serious issues. The Administration does not believe it is time to undertake negotiation of a comprehensive test ban. We would all like to reduce and eventually eliminate our dependence upon nuclear arms. In fact, our efforts to achieve verifiable and stabilizing arms reductions as well as our SDI research program, are aimed toward this objective. Meanwhile, we must rely on and maintain a credible nuclear deterrent for our security and that of our Allies. Our weapons modernization program and confidence in our nuclear deterrent depend critically upon nuclear testing. We must avoid any concern on the part of our Allies about the reliability of the US nuclear deterrent. Such concerns could have serious and far-reaching security consequences. The conventional balance must be considered as well: the USSR's superiority in conventional forces must be dealt with before we abandon our nuclear deterrent.

Q12. Many continue to support the concept of Mutual Assured Destruction (MAD) while opposing the President's Strategic Defense Initiative (SDI) which could result in Mutual Assumed Survival (MAS). If one is interested in the preservation of MAD, which involves the maintenance and even preservation of nuclear weapons for relative stability, why should we support a CTB which would not allow, for very long, the preservation of nuclear weapons through the primary mechanism of testing?

A. A test ban would indeed undermine our ability to maintain confidence in our nuclear weapons, which would in turn undermine deterrence.

Q13. In our last hearing on this subject it was pointed out that the US could simply take an old warhead off the shelf and place it on a new weapon system such as the Midgetman ICBM, yet Dr. Barker, in the August, 1983, edition of Physics Today you state that in every case to date, the replacement system (i.e. newer missile) has required a nuclear weapon different from that of the system it replaces. Can you and Dr. Kerr comment further on this matter?

A. Nuclear weapons currently produced by the United States are replacing older nuclear weapons which are being retired. These new nuclear weapons are required to meet the unique shape, weight, safety, survivability and environmental requirements of new delivery systems. As currently designed, U.S. nuclear warheads cannot be plucked from one weapon system and installed in another weapon system. Absent testing, any changes in the physical environment surrounding a nuclear weapon could degrade its performance, even catastrophically.

Q14. Our national laboratories, for safety and security related reasons, have been in the process of incorporating insensitive high-explosive mixtures which can survive quite violent impacts in new nuclear weapons systems. Because the weapons with the new insensitive explosives are based on new designs that differ substantially from those using older explosives, testing plays a critical role in the conversion to safer nuclear weapons. How would a comprehensive test ban agreement impede conversion to "safer" nuclear weapons?

A. Conversion of already stockpiled weapons from conventional to insensitive high explosive is one example of weapon modernization which would be made impossible by a comprehensive test ban.

Q15. It has been pointed out by some scientists and defense experts that stockpile problems do occur, largely from metallurgical or mechanical problems, or from stricter standards of nuclear safety. How would a CTB impact upon our ability to improve the safety of our warheads and to confound terrorist activity, since newer and safer warheads would require testing?

A. Warhead changes which incorporate improved safety and security features would be impossible under a comprehensive test ban. The absence of such modernization would not make the world a safer place.

Q16. In the normal course of events, a large data base is accumulated about nuclear weapons in the stockpile. To what extent would a data base, for the sake of performance and safety, of scheduled new weapons be affected by a comprehensive test ban?

A. Over the course of time, the existing data base would have less and less relevance to performance and safety. Under a comprehensive test ban we would expect that minor changes, both intentional and inadvertent, would result in a stockpile of weapons differing from weapons that have been fully tested. To the extent that this occurs, the characteristics of those weapons -- such as their yields--and their behavior under different storage or operational conditions would be less accurately known. Eventually, without the experience of nuclear testing future weapon designers could make serious blunders in their application of the inherited data base.

Q17. Have the weapons in the U. S. stockpile been designed deliberately to survive under a prolonged CTB?

- -- If they get sick and need repair, or rebuilding, can this be done with confidence after a long period without testing?
- -- Is testing an essential part of the weapons technology program, or can the weapons technology be maintained by non-nuclear experiments and computer studies?
- -- How does our past experience affect the answer?

A. No weapon in the US stockpile has been intentionally designed to deteriorate. In fact current military requirements for nuclear weapons include a requirement that a nuclear weapon have a lifetime commensurate with the expected useful lifetime of the weapons system. Despite the best efforts of weapon designers to meet such goals, from time to time, unanticipated problems have resulted in significant deterioration in much shorter time. Such deterioration affects weapon yield and weapon safety, and nuclear testing has played a critical role in finding solutions to past problems.

Without nuclear testing, when a weapon does need to be replaced it could be replaced by an improved version only if that version, or something very nearly equivalent to it, had been tested. Otherwise the only alternative would be to attempt to rebuild the weapon according to its original specifications. Often this will not be possible, because original parts are not obtainable, original safety specifications are no longer deemed sufficient, or original materials are no longer available. Testing is an essential part of the R&D process for any new design. Weapons technology cannot be maintained solely by non-nuclear experiments and computer studies.

Our past experience confirms the importance of these conclusions. For example, during the 1958-61 test moratorium, the AEC certified and stockpiled some warheads that were found in later testing to be inoperative. Recent nuclear weapon tests have shown that weapon designers still make mistakes.

Q18. To what extent would a CTB complicate the conservation of scientific skills important to national security? (US scientists and laboratories would eventually confine themselves to other tasks but the Soviet government can order scientists around.)

A. It was discovered during the 1958-61 test moratorium that, even in a 3-year period, there was substantial loss of expertise in the weapons laboratories as a result of the departure of key personnel. On the other hand, the Soviet government was able to maintain a cadre of scientists which conducted the 40-test series with which the Soviets terminated the moratorium.

Q19. What position did the National Laboratory Directors take with regard to tests required to give continued assurance of weapon performance during a CTB of unlimited duration?

A. The present directors of both Los Alamos and Livermore are on record as opposing a comprehensive test ban because in their view continued nuclear testing is absolutely essential to ensure the reliability of nuclear weapons. They have stated that our deterrent depends on nuclear testing. It is their judgment that while non-nuclear tests sometimes detect problems with the nuclear component of warheads, the most serious stockpile problems are revealed and solved only by nuclear tests. In particular, a seemingly minor modification in a weapon design could seriously degrade confidence in performance unless the modified design could be tested with a nuclear yield.

Q23. The September 8, 1983 edition of The Washington Post reported that the Arms Control and Disarmament Agency, in an answer to written questions from the House Appropriations Committee, stated that a test ban could not itself end the threat posed by nuclear weapons, since it does not deal directly with the kinds, numbers, or deployment of nuclear forces. Can you comment on this observation?

A. The United States could not accept a comprehensive test ban at this time because it would endanger the security of the United States and its Allies. Today our security is dependent upon a credible nuclear deterrent. Nuclear testing plays an essential role in ensuring the credibility of that deterrent. A comprehensive test ban treaty cannot be effectively verified and would not result in a reduction in the kinds or numbers of deployed nuclear forces.

Q24. President Carter, in a September 29, 1977 news conference said "I recognize that progress on SALT leads to further progress on a comprehensive test ban." Do you believe that test bans and nuclear arms reductions are interdependent?

- -- Do you believe that arms reductions (talks?) in Geneva can lead to further progress on a comprehensive test ban?
- -- Do you believe that test restrictions should be subordinate to progress on nuclear arms reductions?

A. A comprehensive test ban continues to be a long-term objective of US arms control policy, in the context of broad, deep and verifiable arms reductions, maintenance of a credible nuclear deterrent, expanded confidence-building measures, and improved verification capabilities. Consistent with this long-term objective, the US has given priority to achieving equitable and verifiable arms reductions in the current Geneva negotiations on nuclear and space arms. We must not allow the search for a CTB to become once again a diversion and surrogate for negotiation of deep and meaningful arms reductions.

Q25. Some believe that stopping nuclear testing will somehow reduce the possibility of nuclear war?

-- Can you comment on this observation?

A. We do not agree that a test ban will reduce the risk of nuclear war. Instead, it could result in instabilities that could increase this risk. Nuclear testing plays an essential role in ensuring a credible nuclear deterrent. It is the credible nuclear deterrent which has prevented nuclear war. Its absence can contribute to instability and Soviet actions threatening to US security. And because it is not effectively verifiable, a CTB or moratorium could be violated with very destabilizing consequences.

Q26. Mr. Barker, some argue that if the US and Soviet Union ceased testing, it would signal to other countries that we are serious about ending the arms race and nuclear proliferation. Yet you state in the August, 1983, edition of Physics Today that US confidence in its nuclear deterrent, which could be affected by a CTB, would also have international implications. Can you comment on the impact that a CTB may have on our friends and allies?

A. We would all like to reduce and eventually eliminate our dependence upon nuclear arms. However, our weapons modernization program and confidence in our nuclear deterrent depend upon nuclear testing. Our reliance on nuclear deterrence has an essential bearing on the time frame within which consideration can realistically be given to negotiation of a CTB. We must avoid any concern on the part of our Allies that the US nuclear deterrent can no longer be depended upon. Such concern could have serious and far-reaching security consequences.

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